

ANNALS OF SURGERY

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PRIMARY CARCINOMA OF THE LUNG OR BRONCHUS *

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It is with the most sincere appreciation that I acknowledge the honor which has been paid me in your invitation to give this year the annual Balfour Lecture. Not only is it a privilege to join that distinguished group of surgeons who have preceded me in taking this means of showing their esteem for Donald Balfour, but in addition I count it a high honor to be asked to address the faculty and students of this great medical school.

The interesting coincidence that you have selected Lister's birthday as the occasion for this lecture has been one reason which has induced me to choose the subject of "Primary Carcinoma of the Lung or Bronchus" for my discourse, although the reason is far from obvious. That subject, however, represents perhaps as well as almost any other one the remarkable advance which has been made in medicine since Lister's time. At that time the condition was recognized as somewhat of a curiosity found rarely at the post-mortem table. Its diagnosis during life was practically impossible and there was no treatment which was in any sense effective. Let me quote from the well-known book, "The Diseases of the Lungs," by Fowler and Godlee,¹ which appeared in 1898, two years after Lister retired from practice. This is the same Godlee who was Lister's assistant and later became his biographer. "Primary malignant disease of the lung is a rare condition . . . (Cases of primary tumor of the lung) are extremely rare, the large majority of new growths within the thorax being of mediastinal origin." The discussion of the treatment by Fowler consists of three lines which advise that attempts should be made to relieve the most distressing symptoms. Then follow some paragraphs by Godlee on "Removal of Portions of the Lung or Pleura for Tumours and Other Morbid Conditions" which are devoted almost entirely to the theoretical possibilities of extensive pulmonary resection for tuberculosis. In the closing paragraph he states, "It is very unlikely that primary or secondary tumors of the pleura, and still less likely that tumors of the lung which do not involve the chest wall, will be diagnosed sufficiently early to warrant their removal." Two years before the book just mentioned, and simultaneously with Lister's retirement, there appeared Stephen Paget's² re-

* The "Balfour Lecture" delivered before the University of Toronto School of Medicine, April 5, 1935.

markably interesting book entitled "The Surgery of the Chest." In it he quotes from an address by Réclus before the French Surgical Congress of 1895: "Resection of a part of the lung for primary malignant disease is not even worth discussing. An accessible, single, circumscribed growth would be a clinical wonder that would evade our present powers of observation. The utmost that the surgeon can do is, after the example of Krönlein, to follow even into the lung a sarcoma growing from the chest wall; but this will never be more than one of the brilliant exceptions of surgery." Of equal interest is a statement made by Paget himself, "It is sometimes said that surgeons fifty years hence will think as little of our results as we think of the methods of fifty years ago. So far as regards the surgery of the chest, this is utterly untrue. Fifty years ago, it had risen above the horizon, it is now nearly at its zenith. Indeed, it is possible that we may see its upward movement checked; there are signs that some of the operations that have been proposed and performed for apical phthisis and for bronchiectasis are falling out of favour with surgeons."

When one contrasts the point of view about bronchiogenic carcinoma at the time even of Lister's retirement with that which is prevalent now, about 40 years later, he finds that instead of its being a rare condition, diagnosed only at autopsy and hopeless from the standpoint of effective treatment, it is now regarded as so common as to represent somewhere between 5 and 10 per cent of all carcinomas, to be positively diagnosable in 75 or 80 per cent of cases, and finally to be possible of direct surgical attack, in spite of the gloomy prophecies of those surgeons who were probably the best qualified to speak on the subject only 40 years ago.

It will be well to pause a moment, before entering into the main discussion of our topic, to inquire into the reasons for the remarkable change in our point of view which has come about. The generally accepted idea that the condition is now far more common than formerly is usually ascribed to a supposed actual increase in its incidence due to unknown factors. Although admitting such a possibility I am not entirely willing to accept it. For I believe that many more cases are recognized now even at autopsy that formerly were considered merely as examples of the complications. Indeed, it is the complications or sequelae which are responsible for many of the deaths. A permanent bronchial obstruction from any cause leads to atelectasis and eventually to infection of the lung behind the obstruction. Large or multiple abscesses of the lung, atypical pneumonias, empyemas, *etc.*, with perhaps complicating brain abscesses, may so overshadow a small carcinoma which is blocking a bronchus that the primary lesion may be easily overlooked unless the pathologist is actually looking for it. The fact that the pathologists are now recognizing more of the small obstructive tumors, instead of stopping their examinations at the complications, in my opinion, accounts for much of the present impression that bronchiogenic carcinoma has actually greatly increased in frequency in recent years.

The present ability to establish a positive diagnosis during life in approximately three-quarters of all the cases could not have been possible without

epoch-making discoveries or inventions of two kinds, one of which was the roentgen ray by Roentgen in 1895 and the other direct bronchoscopy by Killian of Mainz in 1898, both occurring at about the time of Lister's retirement. It would not have been possible to operate in the present comparatively satisfactory manner on patients with carcinoma of the lung without the invention of Meltzer and Auer of intratracheal insufflation of air in 1909. The danger of prolonged intrathoracic operations, because of the serious effects of open pneumothorax, was not eliminated in a practical manner by the negative pressure chamber of Sauerbruch because of the complexity of the latter device which made operations of the type necessary very impractical. Again, the possibility of irradiation had to wait until the discovery of the therapeutic effects of the roentgen ray and radium. The change in the point of view of carcinoma of the bronchus is, therefore, another example of the interdependence of important medical discoveries. Just as Lister, the surgeon, made use of the important discoveries of the chemist Pasteur to revolutionize the practice of surgery, so the subject under discussion has required development in various fields of work in order to make it one which can now be approached and attacked in a practical and effective manner. This is the nature of all progress.

The fact that primary carcinoma of the bronchus is no longer to be considered a rare disease is borne out by many statistical reports, of which I shall mention only a few. Perhaps the most interesting compilations of statistics have been those by Junghanns³ and by Weller.⁴ The former, in a collected series of reports from various parts of the world, finds that this type of carcinoma represents from 2.6 to as high as 19.3 per cent of all carcinomas. In Weller's compilation a similar high percentage of primary bronchial carcinoma to other carcinomas is found. It is apparent, therefore, that the old notion that this is a rare disease must be completely discarded and one must at all times bear in mind the possibility of this condition when confronted with a patient who has pulmonary symptoms which are not clearly explainable on some other basis.

Despite the former tendency of some pathologists to think that a primary carcinoma perhaps not infrequently arises from the alveolar epithelium, especially in tuberculosis, the present conception is overwhelmingly in favor of the idea that such an origin rarely, if ever, occurs and that practically all primary carcinomas of the lung originate in a bronchus. Fried⁵ has brought evidence to indicate that these tumors originate in the basal layer of the bronchial epithelium. Tuttle and Womack,⁶ from a study of 60 of our cases, have agreed with Fried's conclusions. In the light of the newer conceptions, therefore, the fact that some of the tumors are composed of squamous cells, some are adenocarcinomas, others have "oat" cells and others present still different cellular structures or a combination of many of them, is all to be explained by a transformation of the basal cell into one of the various types of cells of which different tumors and even different parts of the same tumor are composed.

The signs and symptoms of carcinoma of the bronchus are of interest to

us as practical clinicians chiefly insofar as the early manifestations of the disease are concerned. It is the early symptoms and signs to which we should direct our chief attention because, as in cancer in other parts of the body, our main interest should lie in the disease before it is too far advanced. In other words, we should be more interested in the early evidence pointing to a suspicion of cancer than in the evidence of impending death. In our own cases the most common complaints have been in the following order: Cough, chest pain or discomfort, dyspnea, sputum, hemoptysis or streaking of the sputum with blood, and "chest colds." It is of interest, however, that five of our patients who were proven to have this condition complained of no chest symptoms of any kind. As the disease progresses then, of course, the evidences of complications of various kinds or extension of growth to other organs and of weakness, loss of weight, and cachexia all occur. If one bears in mind that in nearly all cases the tumor arises within the lumen of one of the larger bronchi the clinical picture will be easily understood. Not only will inflammatory changes in the growth produce irritations which will reveal themselves by cough and sputum but also as the tumor enlarges it will almost certainly obstruct the lumen of the bronchus. This obstruction in turn will produce an atelectasis and in the atelectatic portion of lung, sooner or later, infection will occur. The obstruction, however, does not necessarily remain complete. Some variation in the size of the tumor occurs from time to time as the result of edema. This variation in size also results in a variation in the amount of atelectasis and in the amount of drainage of pus in the infected area behind the tumor. In our experience the early symptom of pain is usually due to atelectasis. The intermittency of the bronchial obstruction in the early stages also probably explains the periods of temporary improvement which commonly occur in this condition whether the patients are undergoing treatment or not. I shall not take time to discuss the physical signs. The roentgenologic evidence is of very great importance but it is by no means uniform in all cases. In the majority of instances the roentgenogram does not reveal the tumor. Many roentgenologists, however, apparently assume that a dense shadow which they see in such a case is one produced by the tumor. This shadow, however, usually merely represents the area of atelectasis while the tumor itself, which is obstructing the bronchus, may be scarcely larger than a pea. In other cases, however, the tumor is large and sometimes reveals itself plainly on the roentgenogram. This is especially true in those cases in which it has arisen from one of the smaller bronchi and has invaded a large part of the lung tissue. Any patient free from tuberculosis, particularly if he is of middle age, who reveals on roentgenologic examination an atelectasis of one lobe, should be regarded with suspicion of the possibility of having a carcinoma of the bronchus.

The final diagnosis will usually be determined by the bronchoscope. In from 75 to 80 per cent of cases it is possible to see the tumor through the bronchoscope and to remove a piece of it for biopsy. Other methods of exact diagnosis are sometimes necessary, such as the examination of pleural fluid by the Mandelbaum method, which consists of centrifugalizing the fluid,

fixing the sediment in formalin and embedding and cutting it like any piece of tissue. Another procedure that is sometimes necessary is an exploratory thoracotomy with perhaps a removal of a piece of tissue for biopsy.

Perhaps the most important consideration in the diagnosis of this condition is to have the possibility of it constantly in mind. If it is merely thought of as a possibility many cases will be diagnosed which otherwise would be overlooked. Certainly it is true that any patient of middle age, particularly if a man, who has an unexplainable cough should have a bronchoscopic examination to see if a carcinoma is present. There is now little justification for not making exact pathologic diagnoses in most thoracic ailments. The limitations of time will forbid my entering into an extensive consideration of the diagnosis. Mention should, however, be made of the importance of bronchography by the injection of lipiodol into the tracheobronchial tree in suspicious cases.

From the patient's standpoint the most important consideration is what can be done about the condition and what are his chances of recovery. The simplest method of direct attack on the tumor is by radiation therapy. Unfortunately, however, up to the present time at least, the evidence of the effectiveness of treatment by either radium or the roentgen ray is not very convincing. There are several reasons for this; one is that many of the cases which have been reported as having been benefited by that form of treatment are not proven to have been cases of carcinoma. Again, in some of the cases in which benefits have been reported the length of time which has elapsed between the treatment and the report of the cases has not been sufficient to be a conclusive argument. It is well known, for example, that patients with this disease sometimes live for extraordinarily long periods. I have known of one patient who lived for seven years without any treatment after a positive diagnosis was established. We have had other cases in which the patient lived for as long as five years. Again, most of the reports from the radiotherapists are unsatisfactory because of the scantiness of the pathologic report. The articles in general are illustrated with copious reproductions of roentgenographic films but with no reproductions of the pathologic material. One is usually left in doubt, therefore, as to the validity of the diagnosis of carcinoma, even when a report states that a biopsy was performed and a diagnosis of carcinoma was made. Since, in many cases, the carcinoma is composed of squamous cells one might assume that radiation therapy would be an effective treatment, by analogy with its effect on other squamous cell carcinomas. Certainly, however, when the tumor has become considerably advanced there is no evidence at all that I have been able to find that radiation therapy is effective. For example, that is the recorded experience in nearly all of the clinics where a large number of these cases have been observed and treated. I refer, for example, to the published reports of Sauerbruch and Nissen,⁷ Maxwell and Nicholson⁸ and Tudor Edwards.⁹ Moreover, in 19 of our own patients who were treated by Dr. Sherwood Moore and his staff of the Mallinckrodt Institute of Radiology with thoroughly modern roentgen ray equipment not the slightest beneficial effect could

be observed. On the other hand, there are a few significant observations which have turned up here and there which make it seem possible that in the future, after our knowledge of the subject has increased still more, it may be found that certain kinds of these tumors, or rather certain cases, will respond satisfactorily to radiation therapy. For example, at the last meeting of the American Association for Thoracic Surgery, Tudor Edwards reported a case in which the primary growth was made to disappear completely with radium implanted in the tumor. The patient died, subsequently, however, from metastases. At the same meeting Allen and Smith reported a very striking case in which, after a lobectomy for a carcinoma of the bronchus, the patient showed two and one-half years after the operation a persistence of the tumor in the stump of the bronchus which was made to disappear by the implantation of radon needles. Moreover, on three different occasions since that time, at six month intervals, a recurrence or persistence of the tumor has been found and each time radium has been implanted. Again there is the case of Pancoast, Pendergrass and Tucker¹⁰ in which a "carcinoma of the ancinous-forming type possibly of bronchiogenic origin" was made to disappear by the implantation of gold radon seeds. I have also a patient, now in the hospital, upon whom I attempted a total removal of the lung because of a squamous cell carcinoma of the main bronchus of the right lower lobe. Because of dense adhesions which anchored the lung solidly to the chest wall and to the mediastinal pleura the technical difficulties became so great that it was decided merely to remove the lower lobe. In doing so it was impossible to get above the cancer without much danger of injury to the great vessels. Some cancer was, therefore, left behind. No sutures were placed in the wound, and through the large opening a massive dose of roentgen rays was given by Doctor Moore right at the stump of the bronchus without any intervening tissue of any kind. Six weeks have elapsed since this and the tumor in the bronchus can be seen with the bronchoscope to have almost disappeared. It seems to have been practically completely transformed into a scar. However, at the time of the last bronchoscopic examination by Doctor Arbuckle three radon seeds were implanted into it for additional security. So far as I know this is the only case which has received roentgen therapy in this manner. The principle may have an applicability to other cases in which the technical difficulties preclude the satisfactory surgical removal of the cancer.*

*Two weeks after giving this lecture the patient was examined again with the bronchoscope by Doctor Arbuckle and the tumor in the bronchus was found to have completely disappeared. A biopsy at that time showed only scar tissue. The patient was discharged to his home in a distant city on April 25 but he died of a metastasis to the brain on June 9. His physician wrote that there was no evidence of a recurrence of the carcinoma in the stump of the bronchus. It would seem, therefore, as if the method of giving roentgen ray therapy which was used in this case had been shown to have distinct value in making the local lesion disappear, despite the fact that the patient subsequently died of metastases. The possibility exists both in this case and in the one reported by Tudor Edwards that the metastases which caused death were already present at the time of the beginning of the treatment.

The fact remains, however, that I have been unable to find any incontrovertible evidence that up to the present time any case of primary bronchial carcinoma has been cured by radiation therapy administered in the ordinary ways, although the possibility is admitted that improved technic may in the future actually result in some cures. With this evidence before us it seems to me, therefore, that probably wide surgical removal offers the patient the best chance of recovery from this serious disease provided the operation can be considered to be a feasible one. It seems questionable to me whether the operation of lobectomy will prove to be entirely satisfactory although there are seven cases now in the literature in which there has been a survival for at least one year after operation with no evidence of recurrence. Two of these patients were operated on by Sauerbruch,¹¹ one by Churchill,¹² two by Tudor Edwards,¹³ one by Allen and Smith¹⁴ and one by Young.* In addition Roberts and Nelson¹⁵ have reported a case in which the patient was apparently free from recurrence six months after the operation of lobectomy. Neuhof¹⁶ has had four successful surgical results, but three patients died of metastases within a year after operation, and the fourth had evidence of cerebral metastasis a year later. The objection to the operation of lobectomy for this condition is that it will probably be found not sufficiently radical. It also happens that occasionally one finds that the interlobar fissures are not adequately developed and that, therefore, lobectomy would be difficult or nearly impossible. Finally, in those cases in which there are few if any adhesions the complete removal of the lung is actually about as easy from a technical standpoint as the removal of a single lobe. The complete removal of the lung carries with it the advantage of the ability to remove enlarged mediastinal nodes. Often also it will permit the operator to get closer to the trachea and, therefore, to be more certain of getting beyond the cancer. Since my first case¹⁷ of total removal of the lung at one stage for a carcinoma of the bronchus, which was performed exactly two years ago today, there have been two successful total pneumonectomies for tumor by Rienhoff,¹⁸ two by Overholt,¹⁹ two by Haight,²⁰ one by Flick,²¹ and one by Archibald.²² In addition I have had three other cases in which there seemed to be a demonstration that the operation is feasible despite the fact that the patients died a few weeks later. In one of these cases the patient, three and one-half weeks after the operation, developed a fulminant pneumonia which proved fatal in 36 hours although she had had a normal temperature for two weeks and seemed entirely out of danger. Another one died, also of pneumonia, three weeks after the operation, and the third patient died of a cerebral metastasis. The cases of Rienhoff were apparently not carcinoma but they were cases of tumor. From the standpoint of feasibility of the operation they are of as much value in this discussion as if the operations had been performed for carcinoma. There are thus altogether nine cases of successful

* A recent letter from Mr. W. Arthur Mackey of Professor Young's Clinic states that the patient returned with extensive involvement of his mediastinum three years after the lobectomy.

removal of the whole lung for a tumor performed in one stage which are known to me. Doubtless there have been others which have not yet found their way into the literature or which have not come to my attention. In addition there have been several cases of total removal of a lung for bronchiectasis, but these operations have been performed in multiple stages and for the most part have consisted merely in ligation of the blood supply so that the lung could slough out. Accordingly they are not included in this discussion of total pneumonectomy. The operation, therefore, of total removal of the lung would seem to be one which is practicable from a technical standpoint. The principal technical difficulties are presented when there are extensive adhesions. As improvements in methods are developed, the range of operability will undoubtedly be increased and the operative mortality lowered. Too short a time has elapsed since the operation on any of these patients to permit any deductions concerning permanent cures. My first patient, however, upon whom I operated two years ago is perfectly well and is carrying on a busy obstetric practice.

The study made by Tuttle and Womack of our material at the Barnes Hospital has an important bearing on the question of operability. It was based on a careful review of 44 cases in which the diagnosis of bronchiogenic carcinoma was proven by either biopsy or necropsy, from the records of which it was possible to make certain deductions. Up to the time of their study, a year ago, we had made a diagnosis of primary bronchiogenic carcinoma in 150 cases at the Barnes Hospital. In many of them, however, the diagnosis was based on merely clinical and roentgenologic findings. In some of them, in spite of a bronchoscopic examination, the tumor could not be visualized because it arose in a bronchus too small to admit the instrument. In others the patients either refused to undergo the necessary procedures to establish the diagnosis or it seemed unwise to subject them to the proper examinations because of the advanced state of the disease. In 60 cases, however, a positive diagnosis had been made by the examination of tissue. The 44 cases were selected from the larger group both because in them the diagnosis was definitely established and because of the generally satisfactory nature of the clinical histories and records. From the study by Tuttle and Womack certain important facts seem to stand out which have not hitherto been appreciated. For example, the course of the disease as well as its symptoms depends to a large extent on the portion of the bronchial tree in which the tumor arises. Tumors of the major bronchi give earlier symptoms, extend more slowly, and are more amenable to surgical treatment than those which arise in the minor bronchi and the lung periphery. For example, in 23 cases of tumor of a major bronchus the average duration of life was 26.3 months, and two cases lived for 60 months; on the other hand, in 21 cases in which the tumor arose in a minor bronchus or at the periphery of the lung the average duration of life was only 7.3 months, and the longest duration of life of any individual in the group was 33 months. Also, as might be expected, the same relationship was found to hold true in regard to the

bronchoscopic visualization of the tumor. For example, in those tumors which could be visualized the average duration of life was 33.9 months, and in those which could not be visualized the average was only 13.7 months. The reason for this difference is perhaps not so mysterious as it seems. Apparently it is concerned with the presence of cartilage in the walls of the larger bronchi. The cartilage seems to provide a rather effective barrier which prevents the early breaking through and spread of the tumor.

Their observations made concerning metastases are also interesting. There seems to be a much greater tendency for bronchiogenic carcinoma to invade blood vessels and, therefore, to be disseminated through the body by the blood stream than occurs with carcinoma arising in other structures. There is also, however, the usual tendency to invade the regional lymphatic nodes and consequently one of the early locations of metastatic growths is in the mediastinal lymph nodes. The dissemination of the tumor throughout the body by way of the blood stream leads to the development of metastases in particular organs to a marked extent. The occurrence of metastatic lesions in 30 of our cases, in which a complete autopsy was performed, is seen in Table I.

TABLE I
FREQUENCY OF METASTASES IN VARIOUS ORGANS
A Study of Thirty Autopsied Cases

Organ	No. of Cases	Percentage
Liver.....	13	43.3
Adrenal.....	10	33.3
Brain.....	7	23.3
Kidney.....	8	26.6
Lung.....	7	23.3
Pancreas.....	4	13.3
Spleen.....	3	10.0
Bone.....	2	6.6
Ovary.....	1	3.3
Intestine.....	1	3.3
Skin.....	1	3.3

The fact that in one-third of the cases there were metastatic growths in one or both adrenals is particularly striking. In a similar study Dosquet²³ found the adrenal glands involved in 21.8 per cent. This was contrasted with an incidence of only 4.5 per cent of metastases to the adrenals which he found in carcinoma arising elsewhere than in the bronchus. The brain is another organ in which metastasis is much more frequent in bronchiogenic carcinoma than in carcinoma arising in other parts of the body. Thus in 23.3 per cent of our cases there were metastases in the brain. Those tumors which arise towards the periphery of the lung in our series seemed to develop more metastases in distant organs than those which arose in the larger

bronchi. The possibility of unrecognizable distant metastases will always make the decision to subject a patient to a radical operation more difficult.

Rabin and Neuhof²⁴ are inclined to regard those cases arising at the periphery of the lung as more suitable for operation than those which arise from the larger bronchi. It would seem, however, that they make their decision largely on the fact that in the former type of case the regional lymphatics are less likely to be involved. They comment on the frequency with which distant metastases in other organs are found in that type of case, and it would seem to me, therefore, that their observations are in agreement with those of Tuttle and Womack but that their conclusions regarding the operability are in disagreement with ours. In other words, it would seem to me, in general, that the chance of obtaining a complete eradication of the tumor is greater in a case in which the cancer arises in one of the large bronchi than it is in a case which arises in one of the smaller bronchi or at the periphery of the lung. Five cases in which Neuhof performed an operation would seem to add some justification to the conclusions which I have just made. Three patients died within a year of metastases to distant organs after the removal of the tumor. One death occurred on the third postoperative day and in the fifth case, still living at the time of the report, a little more than a year after the operation, there were symptoms suggestive of a cerebral metastasis.

One of the most discouraging results from the study of any large series of cases is the revelation that nearly all of them have been allowed to progress to an advanced state without so much as a suspicion in the doctors' minds of the true nature of the condition. One can forgive an attending physician for not establishing the diagnosis of bronchiogenic carcinoma because of the expert teamwork that is sometimes necessary. It seems difficult, however, to excuse him when he does not even take the possibility into consideration in a case of unexplained cough which has arisen insidiously in a patient of middle age or older. If the medical profession, as a whole, should appreciate the frequency of this condition, and the necessity and the desirability of taking prompt measures to establish the diagnosis in a suspicious case, probably a great many of the patients might be saved. It is a matter of the greatest importance that educational campaigns should be conducted to inform the general medical profession of the principal signs and symptoms suspicious of this condition and to get them to appreciate that bronchiogenic carcinoma is so frequent that its possibility must always be considered when dealing with a patient with unexplained cough.

The change in the point of view of the profession concerning this condition is well illustrated in a recent experience of ours. From one small city of approximately 100,000 inhabitants not far from St. Louis we have had five patients with bronchiogenic carcinoma within two years. There is nothing peculiar about that city which would make the incidence of the disease any greater there than elsewhere. The true explanation probably lies in the fact that the first patient of the five was a well-known doctor from that city upon

whom we made a positive diagnosis which had previously not even been thought of as a possibility. This fact attracted some attention among the local profession and they have, therefore, been on the alert to recognize other cases. Moreover, we feel that these five patients do not represent, by any means, all of the cases of bronchiogenic carcinoma which have arisen in that city during the time mentioned. The probability is that there have been many more, but the incident tends to show what can be accomplished by the education of the profession to the knowledge of the necessity of thinking of the possibility of bronchiogenic carcinoma.

I am sorry that the limitations of time have prevented me from discussing other phases of this interesting subject of primary carcinoma of the bronchus. I have purposely omitted many features and I have intentionally refrained from a discussion of the various aspects of the operative technic because my desire has been chiefly to emphasize what seemed to me to be the most important features, namely, that the condition is common enough to constitute somewhere between 5 and 10 per cent of all cancers and therefore to be of the same order of frequency as carcinoma of the colon and rectum, that in the great majority of cases it can be positively diagnosed and, finally, that apparently it is not necessarily a hopeless disease. There is good reason to think that direct surgical attack will save many of the victims of this disease, and it is possible that certain other cases will be benefited by some form of radiation therapy.

Finally, I might say to Lister's ghost, if it happens to be present on this occasion, that we are apparently on the verge of another surgical triumph which was probably not even thought of by Lister himself but which was, nevertheless, made possible by the brilliant conceptions of that great benefactor of humanity.

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THE SURGICAL RISK*

WITH SPECIAL REFERENCE TO THE CARDIOVASCULAR SYSTEM

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WE HAVE today reached the place in surgery where, happily, infection is no longer a major concern. Likewise the technic of surgical procedures in nearly all fields has become standardized and there also lies before the surgeon a wide choice of various types of anesthesia. There still is, and probably always will be, room for improvement in technical procedures, but our chief concern is not with these, but with the responsibility of keeping the operative mortality and morbidity to a minimum.

Every surgeon of judgment realizes that this is a complex problem. A short time ago, learning the development of the then new technical procedures in most every field, surgeons were chiefly expected to be anatomists and pathologists. Today they must, in addition, be physiologists, and are expected to have at least a working knowledge of biologic chemistry and bacteriology. In the labor of building up that much-to-be-desired attribute, surgical judgment, surgeons are no longer expected to go ahead alone. Today they turn to their colleagues in many different fields before giving a final opinion as to the operative risk of the patient in question. According to the latest mortality statistics, heart disease is the chief cause of death in our country and any defect in the cardiovascular system is a major concern to every surgeon in estimating the operative risk. Consequently, among those associates who can give the surgeon considerable help, the cardiologist occupies a foremost position.

We have advanced considerably since the days when a stethoscope to the chest in the anesthetizing room was considered sufficient to determine the risk of the patient from the cardiac standpoint. Although the functional capacity of the kidneys was fully investigated, until recently the functional capacity of the myocardium has been overlooked and stress laid on existing valve lesions.

Today, it is of the utmost importance for the surgeon to view heart disease in the light of the newer concepts. In the past 30 years the knowledge of cardiovascular disease has advanced considerably. A newer cardiology has sprung up which has discarded many of the older misconceptions, which, while new, are simpler, more logical, easier to learn and this does not exclude the graphic method of electrocardiography. We believe that fully 90 per cent of the hearts that come under the surgeon's care will be found easier to diagnose and treat if viewed in the light of these newer beliefs.

* Read before the Philadelphia Academy of Surgery, January 14, 1935.

To do this a few of the old beliefs should be abandoned. The circulation is not a simple problem in hydraulics and the heart is not the only motive organ. The peripheral circulation has a great deal to do with the phenomena noted in many surgical patients. The capillaries are receiving the study they richly deserve and many investigators are at work on the problems relative to the autonomic vasomotor centers, which operate, to a large extent, independent of the heart. These mechanisms are operative in shock—a problem receiving a vast amount of surgical study.

If the older classic views of the circulation are revised and the problems presented viewed in the light of the newer physiology all accidents will not be blamed on the heart. Many of the "heart deaths" on surgical services have no feature, when reviewed, that suggests the heart as the principal cause. Many of these deaths are due to peripheral circulatory disturbances, shock, hemorrhage, effect of the anesthetic, or may result from overlooked pneumonia or sepsis. It does not follow that, since the heart of the operated patient has stopped beating, something must have been wrong with the organ.

So, at a time when the surgeon is on the threshold of receiving many more than the usual number of cardiacs on his service, due to the newer studies pointing to the major rôle of the thyroid gland in heart disease, we have considered it advisable to take up for brief consideration a few aspects of the problem of the cardiac risk in surgery.

THE CARDIAC STUDY.—What constitutes the proper study of heart cases on surgical services when operative procedures are contemplated? We have already indicated the folly of basing any opinion on what is heard over the heart by the use of a stethoscope. Good risks with well-established valve lesions may give plenty of murmurs for classification, whereas poor risks may easily slip by if this method and this method alone is used to classify the cases. In recent years, in heart clinics all over the country, order has been brought out of apparent chaos by the use of a system of nomenclature suggested by the American Heart Association. Using this system, certain pertinent questions concerning the heart are recorded and the cardiac diagnosis is viewed from the standpoint of etiology, anatomy, physiology and functional capacity. When this is done the way is paved for viewing the problem of the surgical risk from a place of much greater vantage.

We suggest a small form which follows this system (Chart I), to be filled out by the surgeon and the cardiac consultant before operation. This enables both to cooperate in a preoperative survey and may avoid the necessity of calling for help when the patient is in extremis postoperatively. From the standpoint of the surgical risk you will notice that this form emphasizes the patient's history in regard to the subjective symptoms of dyspnea and chest pain. Answers to these questions, recorded preoperatively, are more important in some types of heart disease, in forming a correct opinion of the patient's risk, than any murmurs or thrills or sounds which may be discovered over the precordium.

THE SURGICAL RISK

CHART I

PREOPERATIVE CARDIOVASCULAR CONSULTATION SHEET

Name: Age: Service of:
Occupation:
Surgical diagnosis:
Operation contemplated:
Past medical history (Résumé):
Family history of cardiac disease?

THE CARDIOVASCULAR STATUS

I. Symptoms

Dyspnea or chest pain (check) { On level
On grade
On stairs
On hurrying
Against the wind

Cardiac pain { Location
Duration
Radiation

Constriction of chest?

Duration of above symptoms:

Are they stationary or progressive?

Is cardiac failure present? Edema? Its extent:

EXAMINATION OF THE CARDIOVASCULAR SYSTEM

Blood pressure: Systolic Diastolic
Peripheral vessels (check): Barely palpable Thickened Tortuous Calcified

The retinal vessels (if examined):

Heart:

Size (record position of apex beat if palpable):

Thrill (location and time):

Heart sounds (intensity; splitting):

Murmurs (location, transmission in erect position and in recumbency):

The rhythm:

Result of electrocardiographic study:

Result of chest x-ray or fluoroscopy:

Orthodiagram:

Cardiovascular diagnosis { (A) Etiologic
(B) Anatomic
(C) Physiologic
(D) Functional capacity

The grade of risk:

Result of operation:

Cardiovascular condition on discharge:

Cardiovascular prognosis:

We often speak of the stress and strain of the operation on the heart, yet this is hardly greater than the work the heart does during the normal activities of any day. If the patient tells us he has no symptoms or shortness of breath or pain, we can be reasonably certain that he will go through the anesthesia and operation with little or no difficulty. We must remember that, even in normal people, there are seen during operation disorders of the

cardiac rhythm, rapid (sometimes paroxysmal) heart action, low blood pressure, respiratory disturbances and cyanosis. These symptoms may arise from a poorly administered anesthetic and the heart may be blameless in their causation. That dilatation of the heart is responsible for the rapid heart actions which are sudden in their onset is a time-honored idea that must be discarded. Curiously enough sudden, rapid heart rates of paroxysmal tachycardia, flutter or fibrillation are many times not cause for alarm, cannot be considered as cardiac emergencies and usually cease spontaneously in an hour or so. Low blood pressure may be the cause of the rapid thready pulse the surgeon many times records and the cause lies in the peripheral circulation and not in the heart. The respiratory changes that are met with may be due to the action of the anesthetic on the respiratory center. In other words, the symptoms that are commonly recorded as cardiac arise, in many instances, from other causes. When we see the skillful anesthetist take patients through long operations with no change in the heart rate, mechanism of the heart beat and with little or no change in the blood pressure and no visible venous engorgement, we realize the importance of choosing the anesthetist and the part the anesthetist has in making the burden borne by the heart indeed a light one.

The features then of a complete heart study before operation consist of an inquiry into the patient's symptoms to determine myocardial function, a survey of the patient's past medical history to search out diseases which are known to affect the heart, a record of all the physical signs elicited and, if possible, fluoroscopic and electrocardiographic examinations to complete the picture. Then comes the review of the case with the surgeon and the consideration of the operation contemplated and a frank discussion of the indications in the light of the prognosis of the existing cardiovascular disease.

THE SURGICAL RISK.—We have, by following the above suggested plan, made a diagnosis under etiology, anatomy, physiology and estimated the functional capacity from the patient's history and findings and are now in a position to formulate certain clinical rules in regard to the surgical risk. At the outset we can emphasize the fact that, for the purpose of operation and anesthesia, a heart which carries its daily burden well without excessive dyspnea or chest pain is equivalent to the normal organ. As Marvin has stated, "No matter what size the heart may be, no matter what thrills or murmurs may be present, and no matter in what direction they are transmitted, if the patient is leading a life of moderate activity without symptoms, the heart may be regarded as the equivalent of a normal one and it may be safely assumed that it will behave properly during operation and anesthesia." There is one exception to this rule. Syphilitic heart disease with advanced aortitis and aortic insufficiency is the type of heart disease where the patient is apt to die suddenly. The mechanism here is rather imperfectly understood, but it is a common experience of clinicians and surgeons who deal with this type of heart. Patients with angina pectoris should likewise be classified as poor or Grade III risks. Here, however, evidence is obtained

in the patient's history of the poor functioning of the myocardium, and the easier the pain is produced the poorer the risk and the shorter the duration of life as a rule. Patients with complete heart block, which is in itself evidence of myocardial damage, usually cannot carry on the ordinary activities of life, and this class of patients we group with the luetic and angina cases as Grade III risks (Chart II). The well-compensated rheumatic heart with

CHART II

THE GRADE OF RISK BASED ON A STUDY OF THE FUNCTIONAL CAPACITY

Grade I	Class I of American Heart Association	Good risk. Here are included patients in whom ordinary physical activity does not cause undue fatigue, palpitation, dyspnca or chest pain, all cases of well-compensated valvular heart disease except the syphilitic, hypersentive heart disease with no renal involvement.
Grade II	Classes 2 (a and b) of American Heart Association	Risk fair with careful medical supervision and preoperative treatment. Emergency surgery only until risk improved. Here we group cases of beginning congestive failure and angina. These cases all show undue fatigue, palpitation, dyspnea or chest pain on <i>ordinary</i> physical activity. All patients classed here can have risk improved to Grade I if operation not emergency.
Grade III	Class 3 of American Heart Association	Surgery contra-indicated. These patients show signs of cardiac insufficiency at rest or signs of active heart infection. They cannot carry on <i>any</i> physical activity without discomfort. Here we include severe angina patients, cases of cardiac decomposition with edema and severe dyspnea and patients with recent coronary occlusion with marked reduction of the myocardial reserve.

or without valvular disease as well as the uncomplicated hypertensive heart we have found stand operation and anesthesia extremely well. When râles at the lung bases, upward trend of the venous pressure readings, and other signs of congestive failure can be elicited, we consider the patient unsafe except for emergency surgery.

CAN THE ELECTROCARDIOGRAM HELP THE SURGEON?—The electrocardiogram can be of great help to the surgeon in its use as a guide to the prognosis of the patient's heart condition. Studies of T-wave negativity are very helpful in establishing at times life expectancy, as has been pointed out by Willius. The electrocardiogram can also be expected to show evidence of recent coronary occlusions which, at times, cannot be diagnosed by the ordinary clinical methods. Muscle damage may also be picked up which will at times aid in evaluating the symptoms of the patient. It is evident that the electrocardiogram cannot be expected to furnish the surgeon with a machine diagnosis. The tracing is of no value in most instances unless considered along with the patient's clinical history and findings, as recorded on the study sheet. The cardiac arhythmias may be very nicely studied by using the electrocardiogram, but after more careful clinical observations, surgeons should not

have to depend on this instrument for a diagnosis of these irregularities. It may be broadly stated that none are important except heart block and pulsus alternans. The sudden onset of one of the paroxysmal, cardiac arrhythmias, such as auricular tachycardia, auricular flutter or auricular fibrillation may cause the surgeon great alarm. These mechanisms are apt to occur at any time, and usually do not constitute cardiac emergencies in the strict sense of the term. The patient may give a history of paroxysms of tachycardia for many years which have appeared and disappeared very quickly and caused the patient little or no inconvenience. It may be assumed that these mechanisms will behave in the same way when the patient is in the hands of the surgeon. The electrocardiogram is helpful in differentiating these various types of disorder of the heart beat, and perhaps throws some etiologic light on the condition. If the patient is let alone, these mechanisms usually cease as quickly as they start and in the absence of circulatory failure they should be allowed to do so.

CAN RISK BE IMPROVED?—Coöperation of surgeon and cardiologist certainly makes it possible to improve the risk by proper treatment. Early congestive failure certainly calls for delay in operation wherever possible until the evidences are cleared up by rest and digitalis. When this result is achieved the risk is greatly improved. Venous pressure readings will sometimes aid in controlling the digitalis medication and in deciding the time to operate where the usual signs of congestive failure are obscured. This same rule holds good for obstetricians when their patients, usually rheumatic with mitral stenosis, come in with congestive failure. Then the clearing up of the evidence of circulatory stasis should be accomplished before the patient is delivered.

The surgeon sometimes shows considerable indecision in the use of digitalis in improving the cardiac risk. We believe that digitalis is indicated only in the presence of some evidence of congestive failure or when permanent auricular fibrillation is present with a high ventricular rate.

Some surgeons give digitalis routinely before operation in all their cardiovascular cases. This they do in spite of the fact that the patient's history shows no functional impairment in the circulation in carrying on the ordinary activities of life. If this evidence of a good circulation is present how can it be further improved by the use of the drug? It may be that surgeons believe that digitalis has an effect in sustaining blood pressure and in increasing the "myocardial tone." This, statistics have shown, the drug fails to do. Likewise, there is no evidence that digitalis prevents hypostatic pneumonia in old people undergoing surgical operation. On the other hand there is evidence that digitalis in normal people actually causes a decrease in the volume output of the heart. We believe that digitalis should be given in its full dosage or withheld altogether.

CARDIAC ACCIDENTS.—In those patients giving a history of angina pectoris or who have had one or more coronary occlusions, the surgeon is presented with the possibility that the same accident may happen under his care

as it would during the ordinary exertions of everyday life. We do not believe that surgical operations are frequently the cause of the precipitation of such complications. However, should the operation be attended by such complications as sepsis or pneumonia, these factors may be potent in precipitating the cardiac complication. When surgery is imperative in the midst of an attack of coronary thrombosis it must be expected that the mortality will be high just the same as it would be if the patient were under the care of the cardiologist in the medical ward. The sudden death in syphilitic heart patients, undergoing major surgery, may be expected and cannot be prevented. The chief cause of death among cardiac patients after coronary occlusion is perhaps congestive failure, which occurs usually during the postoperative period. Embolic accidents and cerebral accidents are the next most frequently met with. It may also be stated that heart cases react particularly badly in the presence of postoperative infection or pneumonia. Congestive failure can, perhaps, be made an insignificant factor in the causation of death in the cardiac cases, if it is recognized and promptly treated before operation.

CARDIAC DISEASES SMULATING SURGICAL EMERGENCIES.—Careful study of the patient's cardiovascular system will usually prevent these mistakes in diagnosis. Cases of acute coronary occlusion have been known many times to masquerade as surgical emergencies. Many times the features of these cases, including abdominal rigidity, pain, leukocytosis and shock, have been very typical of ruptured gallbladder or ruptured duodenal ulcer or acute appendicitis. A careful cardiac check-up with electrocardiographic examination and a careful physical examination of the chest will give the surgeon the clue as to the real nature of the emergency. In children particularly, acute pericarditis may closely simulate acute appendicitis. In all these cases, the abdominal reference of the pain, with its accompanying rigidity, has been the confusing sign. So it behooves the surgeon in these cases to make a supradiaphragmatic survey with the help of the cardiologist before scheduling a patient for operation. Likewise, if the surgeon is not constantly on the lookout for the heart of congestive failure, the signs of which are just as easy of recognition for him as for the cardiologist, the acutely swollen liver may at times be mistaken for gallbladder disease.

Factors in Treatment.—We have already spoken at some length with regard to the use of digitalis in improving the surgical risk. We have tried to give its indications and contra-indications. Another valuable drug not generally appreciated, possibly because its contra-indications have been greatly exaggerated, is quinidine. At times, the use of this drug may prove a life saving measure. There are instances, chiefly occurring postoperatively, where abnormal cardiac mechanisms, such as paroxysmal tachycardia, auricular fibrillation or flutter come on in the sclerotic heart with little cardiac reserve and then are not harmless but are the outstanding factors in precipitating an attack of congestive failure. In these instances, the quicker the heart is relieved of its excessive rate and the sooner diastolic filling can be prolonged, the better will be the outlook for the patient. Should the rapid rate be pro-

I shall not discuss further syphilitic or arteriosclerotic disease. I would like to say just a word upon the subject of hypertension. When the systolic blood pressure is persistently over 140 and the diastolic over 90, hypertension is present. It can be accepted as a fact that no heart can withstand the strain of hypertension long and remain normal. It must hypertrophy at least, and a hypertrophied heart is not a normal heart. Therefore, every time a hypertensive individual is operated upon, there is some risk of circulatory collapse. The risk, however, is more or less proportional to the degree of damage. The amount of damage sustained, however, is not always proportional to the degree of hypertension. How badly the heart has suffered and therefore how great the risk can be determined only by applying to each subject the careful thorough clinical and graphic studies that Doctor Leaman has discussed.

I believe the subject of the risk of the heart in surgery is a most profitable one for both surgeons and internists to discuss. It is a subject that is certainly most important. The rôle of the internist in helping to decide if a given heart can withstand surgery is often a most difficult one. However, I believe that careful study of the matter and the thorough application of all modern methods will do much toward lowering the mortality from circulatory failure during and after surgical interference.

DR. I. S. RAVDIN (Philadelphia).—Fitz-Hugh and Wolferth (ANNALS OF SURGERY, vol. 101, p. 478, 1935) have called attention to the improvement in the electrocardiographic picture which occurred in patients having coincident cardiac and biliary tract disease after removal of a diseased gall-bladder. They concluded, "These electrocardiographic data, together with the clinical data, indicate an apparently beneficial effect on the heart from successful removal of gallstones in these cases." We have had 16 patients all showing moderate or severe myocardial disease with only one patient dying as a direct result of the operation, and this patient died in the hospital. Several of these cases had been bedridden for months prior to operation and on the whole they were decidedly improved subsequent to operation. It is my impression, at present, that patients with evidence of moderate cardiac disease, as long as they are compensating, will stand biliary tract operations very well.

DR. WALTER E. LEE (Philadelphia).—As desirable as it would be for the surgeon to be able to obtain an accurate estimate preoperatively of the patient's cardiovascular system, I must admit from my own experience that the internist's prognosis is far from infallible, nor are they always of help in making a differential diagnosis between coronary thrombosis and abdominal catastrophe. Only last month we had two cases in which we disagreed with the internist. In the first one the surgeon diagnosed coronary thrombosis and the internist disagreed. At the end of 18 hours an electrocardiogram showed characteristic changes of coronary disease. This man was not operated upon. The second patient was diagnosed by the internist as a case of coronary thrombosis and was not operated upon, and 48 hours later he developed all of the characteristic symptoms of a perforation into the peritoneal cavity. I do not know of any surgical problem in which we need more help than in the differentiation between coronary thrombosis and abdominal catastrophe, and I cannot feel that at the present time we have as much help as we would like to have from the internist.

DR. EDWARD J. KLOPP (Philadelphia) recalled a man who was sent into the hospital with a diagnosis of a perforated duodenal ulcer. We thought

the man had coronary occlusion, whereupon an internist of national reputation was consulted and he thought he had a perforated ulcer, but it was my impression that he was too ill to be operated upon immediately. The following day he was autopsied. He had both a perforated ulcer and also a complete coronary occlusion.

DR. JOHN S. RODMAN (Philadelphia).—I have been very much interested in Doctor Leaman's work with us during the last year, he certainly has helped us a great deal, and has added to my comfort in assuming the responsibility for the risk in these patients. One of the outstanding points in his paper, I believe, is that if the handicapped heart patient can go about without discomfort, he is apt to go through any surgical procedure safely. This we have seen happen repeatedly. It is an important new phase in our modern technic to estimate the risk by electrocardiographic study. The heart with valvular lesions, providing it is compensating, will stand any surgical risk within reason. It is often impossible to pick up muscular damage without the help of the cardiologist, and if you do, it is life saving surgery to do the least surgery possible. A good example of this is the gallbladder case for whom it is better to do a cholecystostomy than a cholecystectomy if cardiac damage is found.

THE RENAL PHASE OF SURGICAL RISK*

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THE renal phase of surgical risk is a subject to which the surgeon himself has contributed very largely and it does not represent simply a phase of internal medicine.

The greatest contribution to our knowledge of the kidney in disease was made by that famous English clinician, Richard Bright. Although his laboratory equipment consisted of but a spoon and a candle, he established the clinical significance of albuminuria. He collected under one roof all sorts and kinds of patients suffering from albuminuria. On these patients he took careful histories, made thorough physical examinations and did urinalyses, such as they were in his day. He followed those who died to the autopsy table. He taught the medical profession the clinical picture, the diagnosis, the prognosis and treatment of nephritis, Bright's disease. He went even further and indicated the great fundamental problems concerned in nephritis. If we, as medical men, had had the wit to read between the lines, we might have known as much 50 years ago about kidney disease as we know today. Now, as in the day of Bright, every surgical case should be subjected to a routine physical examination, a careful history, and a urinalysis both chemical and microscopic.

Recent work has revealed new information relative to urinary proteins. Normally albumin is lacking in the urine but in health it may reach as high as 40 to 50 mg. per day. Increased urinary protein usually indicates increased permeability or injury of the glomeruli. As a rule, in most diseases of the kidney, albumin is the predominating protein in the urine. It may reach as high as 50 Gm. a day in certain cases of nephritis, especially in nephrosis, thus robbing the body of its albumin content. In certain other diseases globulin predominates, particularly in multiple myeloma which is characterized by a Bence-Jones proteinuria.

The protein in the urine is derived as a rule from the proteins of the blood. Normally the total plasma protein varies from 6.5 to 7 per cent. The serum albumin constitutes 4 to 5 per cent; the globulin 2 to 5 per cent and the serum fibrinogen 0.2 to 0.4 per cent. Serum albumin exerts four times as much osmotic pressure, weight for weight, as serum globulin.

In disease, fluctuations from these values are common, usually a decrease in the albumin and frequently compensatory increase in globulin. The body is capable of regenerating 25 Gm. of serum albumin per day. When the urinary loss exceeds this, the body becomes deficient in serum albumin. When this reaches a critical point, edema is apt to develop. The critical point is represented by a plasma protein of 5.5 per cent with a serum albumin of 2.5 per cent.

* Read before the Philadelphia Academy of Surgery, January 14, 1935.

Much discussion has been accorded the albumin-globulin ratio in relation to the development of edema but the reduction in total plasma protein is the most important consideration. Naturally the level of the electrolytes is also of significance.

Thomas Addis, one of the greatest students of diseases of the kidney of modern times, has given us a quantitative method for the study of the formed elements as well as for albumin in the urine. In this he has included the red blood cells, the white blood cells and the various forms of casts. He also has discovered the broad "renal failure cast" which has a marked prognostic significance in the terminal phases of the hemorrhagic type of nephritis.

The greatest progress in evaluating the renal phase of surgical risk concerns the use of tests of renal function. It behooves us, therefore, to understand the normal as well as deranged function of the kidney. The function of the kidney is to maintain homeostasis through the elimination from the blood through the urine of all excessive superfluous or waste products: (1) excretion of water and salt, maintenance of the water balance of the body; (2) excretion of end products of metabolism; (3) maintenance of acid-base equilibrium; (4) synthesis as exemplified in hippuric acid; and (5) control of hormonal content of the blood.

The work of the kidney may be summarized in tabular form as follows: All of these functions might probably be utilized in determining renal function. Many of them have already come into use in this connection.

The tests of renal function may be divided into three groups: (1) tests of excretory capacity; (2) tests of retention; (3) tests of rates of excretion. Of the tests of excretory capacity, the water test of Albarran was one of the earliest tests introduced. It is still of great importance in determining matters pertaining to dilution and concentration of urine. Chemicals have been utilized also for tests of excretion. Among these are potassium iodide, lactose, salicylates, sodium chloride, urea and sugar following the administration of phloridzin. None of these, aside from the excretion of sodium chloride and urea, is employed frequently at the present time. The excretion of enzymes, particularly diastase, is a test introduced in Germany by Wolgemuth. Finally, there are the tests based on the excretion of dyes, methylene blue, indigo carmine, rosaniline and phenolsulphonphthalein, the latter introduced in 1910. Of these, the indigo carmine test is still in common use and is of particular value in chromocystoscopy; the phthalein test has constituted the standard test of renal function during the last quarter of a century.

The tests of retention which have been employed are: (1) the concentration of ions as determined by the electrical conductivity; (2) the concentration of molecules and ions as determined by cryoscopy; (3) the level of cholesterol in the blood; (4) the level of the total incoagulable nitrogen or the total non-protein nitrogen in the blood, a test of great value; (5) the level of the blood urea which has been determined by various methods, those of Doremus, Marshall, Hench, Van Slyke, and Carr. The level of blood urea is perhaps the most commonly used test of renal function. (6) The level of creatinine,

uric acid, phosphorus and sulphates in the blood also yield significant information as to the function of the kidney. The most important of these are the level of the blood urea, creatinine, phosphorus and sulphates.

The coefficients of the excretion of various substances have been utilized for three decades. The rate of excretion of urea has been the test most commonly employed. This began with the constant of Ambard and is now utilized as the urea clearance test of Van Slyke. This is regarded by many as the most delicate index of renal function. The rate of excretion of other substances, however, may be utilized. The fractional output of phenolsulphonphthalein was advocated by Shaw. Likewise the creatinine filtration or clearance test was advocated by Rehberg and the rate of excretion of sulphates was introduced by Wakefield, Keith and Macy, all yielding an index which is just as delicate and of equal efficiency as that obtained with urea clearance. Some of the formulae now employed for determining the rate of urea level are appended (Table I).

TABLE I

Functional Test	Value Determined
Urea concentration in urine.....	U
Urea concentration in blood.....	B
Concentration ratio between urine and blood	$\frac{U}{B}$
	B^*
Ambard's urea-secretory constant. Original form	$\sqrt{D \times \frac{70}{\text{weight}}} \times \sqrt{\frac{U}{25}}$
Addis urea excretion ratio (maximum blood clearance)	$\frac{D}{B}$ or $\frac{UV}{B}$
Standard blood clearance.....	$\frac{U}{B} \sqrt{V}$

Other tests of renal function are the urinary concentration tests relative to food and water intake introduced by Schlayer and Hedinger and simplified by Mosenthal. The urea ratio, the ratio of urea nitrogen to total non-protein nitrogen in the blood, has always been regarded as significant. It was emphasized by Mosenthal and Bruger. The synthesis of hippuric acid after the feeding of benzoic acid was a test introduced by Kingsbury.

Acidosis and alkalosis are important relative to renal function. They are always secondary in nature and are readily revealed by the carbon dioxide combining power of the blood. One may see increasing acidosis ending in uremia and death; cases in which alkali treatment has been administered in acidosis with a clearing up of the acidosis without effect upon the progress of uremia; and cases of severe acidosis and acute nephritis with complete recovery

and return to normal of the carbon dioxide combining power of the blood and the urea nitrogen.

It is just as important to recognize alkalosis as acidosis. This is often encountered in high intestinal obstruction. By means of functional tests, especially the creatinine content and the carbon dioxide carrying capacity of the blood, it is possible to determine the extent of the risk. The effects of adequate treatment with saline solution can be followed and the best time for operation determined with nicety. Recognition of the importance of alkalosis, particularly in high intestinal obstruction, has led to the saving of many lives (Table II).

TABLE II
The Work of the Kidney

Water	Solids		Acid	Base
	Organic	Inorganic	cc. 1/10 N	cc. 1/10 N
	35.2 Gm.	22.7 Gm.	2548	2368
12-1500 cc.	Urea..... 32.0	NaCl..... 14.0	P..... 925	Ca.... 365
	Creatinin..... 1.8	H ₃ PO ₄ 2.0	Cl.... 810	Mg... 283
	Uric acid..... 0.7	H ₂ SO ₄ 2.6	S..... 813	K.... 870
	NH ₃ 0.7	K ₂ O..... 3.0		Na .. 850
	Hippuric acid. 0.8	Mg & CaO... 0.9		
	Rest N..... 2.2	Rest..... 0.2		

A few words should be said concerning the use of the phthalein test and other dyes given intravenously. For greater delicacy, they may be employed in this way. When the phthalein test is so utilized, 55 per cent represents the normal excretion for the first half hour, a point emphasized in the original publications. Fractional excretion at 10 to 15 minutes has been employed by Shaw, Young, Chapman and Halsted. The latter workers have employed it together with the urea clearance test and claim that it yields information identical with that obtained from the latter. Because of the simplicity of the technic, they regard it as the functional test of choice. Machado Macedo of Portugal has advocated the combining of the intravenous phthalein and the rate of urea excretion in one procedure for the determination of renal function. He regards the output of phthalein as the most delicate index in determining the rate of urea excretion. He utilized his own formula $\frac{UR}{D}$.

After 25 years' experience with functional tests, I believe that the degree of renal involvement can be determined quite accurately even by the general practitioner. In accomplishing this he will need: (1) measuring cylinders and urinometers; (2) test tubes and reagents for determining albumin and sugar; (3) microscope and slides; (4) blood pressure apparatus; (5) ophthalmoscope; (6) phenolsulphonphthalein outfit. The concentration and dilution of urine as determined by the Mosenthal or Newburgh methods reveals information of great significance. Many physicians fail to appreciate the value

of the ophthalmoscope in the study of the kidney. It should be remembered that diagnostically the retina may represent the polished surface that takes the fingerprints of disease and that prognostically it often becomes Belshazzar's wall on which the fate of the patient is written.

Another field in which real progress has been made is in roentgenography of the kidney. This often reveals unexpected information which is of greatest importance to the patient. This may be obtained at times with flat films or by retrograde urography which has to do essentially with the location of the kidneys, with the shadows of the pelvis of the kidney, of the ureters, bladder and sometimes of the urethra.

More than this is necessary. What is most needed at present is a method for revealing the total size of the kidney. This we attempted to do some years ago through the use of the intravenous injection of sodium iodide. Although our work failed of its main objective, it did result in the development of the field of intravenous urography. While this must be regarded as an important development, it does not solve one of our most important problems.

I believe that the clear delineation of the kidney by roentgenography is the next great step necessary in the understanding of the kidney in disease. In many instances I am certain it will afford information just as important and, in some respects, more important, than that revealed through the use of functional tests. In this connection we have been working with Dr. B. P. Widmann and Dr. John Lansbury and by means of six foot films have succeeded in showing the outline of the kidney, in some instances through the utilization of several films. The surface of such a kidney, obtained at autopsy, has been measured with a planimeter by Doctor Lansbury and, utilizing the formula—Area multiplied by the square root of Area divided by three—he has succeeded in calculating the weight of such a kidney within the limits of plus or minus 10 per cent. The great need is for a procedure whereby the outline of the kidney may be boldly delineated and the total kidney substance ascertained. Having failed to solve this problem to our own satisfaction, we are eager to see it taken up by others or to have suggested to us some method whereby this may be accomplished.

It is apparent that in determining the renal phase of surgical risk a broad approach must be made involving many considerations. Among these should be mentioned (1) the nature, duration and severity of the disease present; (2) special considerations relating to the condition of the kidney, cardiovascular system, urinary tract, lungs, blood and intestine; (3) the results of the renal functional tests and urography; (4) the type of operation involved; (5) the caliber of the surgeon and his organization. The most important consideration from the patient's point of view is probably the selection of the surgeon. If the surgeon and his organization are all that they should be, all the important requirements of the particular case will receive adequate consideration. This will include preoperative care, the choice of anesthesia, the severity of the operation and the nature of postoperative management. When all goes well, the surgeon will suffice but when difficulties are encountered, the help of the internist may prove of value.

PANTOCAIN IN SPINAL ANESTHESIA*

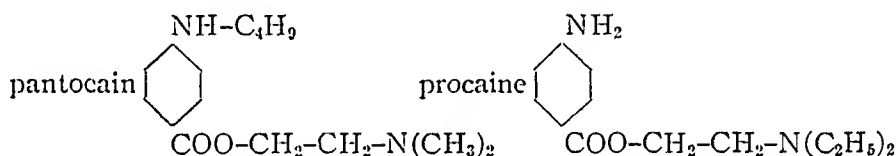
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SPINAL anesthesia has appealed to surgeons through its facilitation of their work due to the superior relaxation it provides. The use of procaine and its equivalents novocain, neocaine, and spinocaine has made the "spinal belly" a descriptive term. On account of its relatively short duration, procaine, however, was found inadequate in some of the very procedures where it would have been most appreciated. The search for an anesthetic of more prolonged action has led to the examination of a number of drugs among which was pantocain.

Its structural formula is similar to that of procaine from which it is derived.



It is supplied commercially in 1 per cent solution as a colorless liquid with a toxicity six times that of procaine,¹ but its smaller effective dosage makes it no more toxic in practice. We are told that when a lethal dose is given intravenously animals invariably die of respiratory paralysis and that its effect on circulation is not to be feared as doses many times that used intraspinally are required to cause a significant drop of blood pressure.² It must be remembered that these data as to toxicity apply to intravenous rather than intrathecal use. The specific gravity in 1 per cent solution is 1.0068 at 25° C. as compared with spinal fluid which may vary under normal conditions from 1.001 to 1.009. So the solution, while designed to be of equal density, may be actually heavier or lighter than a particular spinal fluid.

As this relation is important to the operator in a given case, we have employed a test solution devised by Dr. Hans Clarke, consisting of a mixture of xylol and chlorobenzene in proportions to have a specific gravity equal to that of the pantocain solution. This fluid does not mix with spinal fluid. Therefore, when spinal fluid is dropped into a tube of the test solution it is found to be heavier or lighter than pantocain, depending upon whether it sinks or floats.

The drug is administered with the usual sterile precautions in the lateral recumbent position. Ephedrin (50 to 125 mg.) is injected into the erector spinae muscles through a novocain wheal and through a similar wheal over

* Read before the New York Surgical Society, March 13, 1935.

an interspace of the lumbar spine appropriately chosen to give the desired level of anesthesia, as the second lumbar; a fine gauge needle (No. 22) is introduced into the subdural space. One drop of spinal fluid is used to determine its relative specific gravity. When five minutes have elapsed from the time of ephedrin injection, 2 cc. of pantocain solution plus an equal amount of spinal fluid are slowly injected. As little as .5 cc. suffices for the lowest anesthetics and dilution with spinal fluid is used only to raise the level of anesthesia. The patient returns to supine position on a flat table and the head is raised to prevent the drug from reaching the cervical region, providing of course the spinal fluid is lighter than the drug, as is almost always the case. The table is not tilted unless the operation demands Trendelenburg position and this, not until 20 to 25 minutes have elapsed, which is the period required for fixation of the drug. Almost immediately after injection a satisfactory anesthesia to the nipple line will be found established.

This anesthesia lasts about three hours, though by appropriate modifications of technic a range of three-quarters to five hours can be produced. The patient usually dozes throughout the operative procedure due to premedication with nembutal or some other barbiturate plus morphine. Many prefer paraldehyde on account of the uncertain action of the barbiturates which sometimes excite. The patient breathes quietly but on request takes deep inhalations. His blood pressure rises as the ephedrin takes effect perhaps 20 Mm. and is lowered with the spinal injection to his anteoperative pressure or even slightly below. His intestinal caliber is diminished but the collapsed or ribbon gut seen with procaine is absent. He exhibits the typical abdominal relaxation seen in all spinal anesthesia, but may respond to traction on the mesentery by retching or even vomiting, unless anesthesia reaches the second dorsal interspace. The operation may be completed without especial haste. He recovers from his drowsy state slowly without nausea and unless contra-indicated by the nature of the operation may take fluids immediately. His head is not raised for 24 hours. The anesthesia clears from above downward and disappears last in the feet and lower abdomen, that is, in the area supplied by roots at the site of injection.

There is no dearth of experimental data on the action of spinal anesthetics in general and some on pantocain in particular, although it is sometimes conflicting. It might be profitable to compare it with clinical observations.

It is not universally accepted that spinal anesthesia is due to paralysis of nerve roots. It has been thought of as a cord paralysis. It was thought that if a band of anesthesia could be produced, the point would be proven. This was accomplished by injecting 1 cc. of 1 per cent pantocain in the sixth dorsal interspace for a chest operation. Anesthesia extended from the second dorsal interspace to the navel, but below this point there was no sensory or motor paralysis.

If one considers the dural sac of a horizontal patient as a tube containing a watery fluid of 1.004 specific gravity, when a small amount of fluid of specific gravity 1.006 is introduced, it will lie beneath the spinal fluid and bathe the

posterior roots, except as it may diffuse anteriorly before being taken up into nerve tissue. By diffusion we do not mean the molecular phenomenon of physics. This process is too slow to act within the period when the drug is free. We refer simply to a mechanical dispersion of the drug by the swirling of rapid injection.

When a typical spinal anesthesia is given by injection through a lumbar interspace it is usually noted that the anesthesia begins in the feet and perineum and progresses cephalad. Similarly it clears from above downward, disappearing last in the roots at the site of injection. This must mean that the concentration of the drug at a given spinal root determines the duration of its corresponding area of anesthesia and that the greatest concentration is at the site of injection. Involvement of other levels then depends upon diffusion or upon flow by gravity along the posterior trough of the dural tube. An example of the spread by flow is found in the many observations of anesthesia to the second cervical without embarrassment of respiration. The drug evidently travels from the twelfth dorsal by flow along the posterior aspect of the cord. If there were an appreciable concentration of the drug in contact with anterior roots these would be involved with paralysis of the phrenics as it passed cervical three, four and five. To be sure, another factor may be involved—greater susceptibility to local anesthetics of sensory as compared with motor fibers. The necessity for slow injection to minimize diffusion is apparent and the danger of lowering the patient's head prematurely is seen to depend upon the flow of the drug to a higher level than planned.

All these phenomena have been demonstrated visually, by injecting into a horizontal tube containing a colorless liquid a somewhat heavier one of contrasting color.

The drop in blood pressure incident to spinal anesthesia has been accounted for in various ways by experimenters. Four groups of cases have furnished observations which seem significant:

(1) Anesthetics limited to the perineum without use of ephedrin have depressed blood pressure none or less than 8 Mm.

(2) Those for the upper abdomen, unless ephedrin is used, have produced a maximum drop.

(3) Those extending to the upper cervical region show no greater drop.

(4) In cases exhibiting temporary respiratory failure the blood pressure has been as well sustained.

The fall of blood pressure, therefore, can hardly be due simply to decreased respiratory movements; nor can it depend upon the toxicity of the drug systemically since the dosage has been constant. The drop does occur, however, whenever the anesthesia includes the upper abdomen, that is, when the segments from the ninth dorsal to the second lumbar are anesthetized. It is of interest that these roots are chosen for section in operations for essential hypertension as those whose division produces the greatest effect.

It is not apparent why pantocain depresses blood pressure less than procaine, yet this has been our experience and that of others who have reported. We

have noted that the collapse of the intestine is less. If this may be taken as an index of effect on sympathetic fibers, it may in part explain the lessened vasomotor effect.

The postoperative complications have been studied by comparing records of 1,651 cases done under procaine, 606 under pantocain and 1,198 under avertin. Shock attributed to the anesthetic was encountered with procaine 51 times, with avertin 12 times, but with pantocain only once. Headache of severe grade was recorded eight times with procaine while none is recorded against avertin or pantocain. However, pantocain is credited with two of mild degree. Catheterization followed 25.4 per cent of the procaine anesthetics, 21.4 per cent of the avertin, but only 2 per cent of the smaller pantocain series. Unexplained death at intervals of 3 to 42 days followed procaine once and pantocain twice. There have been several neurologic sequelae following procaine but none following pantocain. Spinal fluid cell counts done 24 hours after operation have shown no significant rises to suggest a local irritation by the drug. One case showed 85 cells—mostly lymphocytes, in the presence of a red cell count of 2,000. It was assumed that blood had been the irritant.

An important purpose in using spinal anesthesia has been avoidance of respiratory complications. In a series of 596 operations under neocaine, compared with a parallel series of 1,198 done under avertin-gas-oxygen, the gross incidence of postoperative pneumonia was 10.5 per cent *versus* 4.6 per cent in favor of avertin. The corresponding figure for pantocain was 4.5 per cent. In the neocaine series, however, 47.7 per cent had known anteoperative major or minor respiratory complications while the avertin series contained one-half this number. Excluding these, the figures are 1.67 per cent *versus* 2.3 per cent—a 37 per cent advantage for spinal. Again, in the presence of a minor anteoperative respiratory complication, pneumonia followed in 1.37 per cent spinal anesthesia cases against 8.2 per cent for avertin. In the face of a major anteoperative respiratory complication, spinal anesthesia showed no statistical superiority. Obviously, then, from the standpoint of pneumonia spinal anesthesia's special indication is the presence of a cold or sore throat. Of importance to us, however, were the figures when spinal anesthesia was supplemented with gas and oxygen. These showed no advantage for spinal, and again demonstrated strikingly the need for a drug giving a more prolonged effect.

Since these figures show a lower incidence of postoperative complications in most respects than procaine or avertin, we feel safe in saying that pantocain is well tolerated.

It is only fair to note that ephedrin should be credited with a certain share of the improved postoperative course seen after pantocain. In most cases procaine was given without ephedrin or the ephedrin was given subcutaneously or at too short an interval before the anesthetic. The unimportance of the immediate fall of blood pressure is not in accordance with our experience. The subjects showing the greatest depression of blood pressure have, as a group, shown complications in greater number and in greater severity. Nausea

and vomiting on the table are not the only sequelae due, in whole or in part, to this phenomenon.

However, pantocain has one very serious drawback. We have had 14 cases of respiratory failure, two of which were fatal. Procaine also has provided four, with two deaths, but in a series two and one-half times as large. The sequence of events in each case has been much the same, the picture being a progressive paralysis of the muscles of respiration. As the level of anesthesia rises intercostal paralysis takes place, the patient becoming without distress an abdominal breather. Spoken voice still remains. As the anesthesia begins to affect the phrenic nerves, abdominal breathing becomes lessened, the alae nasae begin to distend, and the voice is whispered. From here the picture advances quite rapidly, the accessory muscles of the neck are brought into full play, the head is moved to and fro, the chin begins to drop with each respiratory effort, the patient becomes unable to speak, although he can move his tongue, and finally there is a rolling of the eyes with loss of consciousness and dilation of the pupils with cyanosis.

Resuscitation has been accomplished with artificial respiration. With a tight fitting mask and a rebreathing bag containing oxygen and carbon dioxide under positive pressure, patients have been carried along for periods of 5 to 95 minutes, by alternately compressing and releasing the bag. The 12 patients who recovered showed no further ill effects.

We have no doubt that these accidents were caused by the induction of a level of anesthesia which was too high, and that one or more of the following technical errors was responsible in each case:

- (1) Administration of the drug with patient in sitting position.
- (2) Lowering the head of the table before the drug had been fixed.
- (3) Too great an amount or volume of the drug, too rapidly injected.

The first death was caused by an overdose and lowering the head. The patient was a short, obese woman of 46, whose thoracic spine was too short for a large volume of the drug and premature tilting of the table. Respiration began to fail 14 minutes after the injection, followed by circulatory collapse in five more.

The second death also was caused by too great a volume of anesthetic. A 31-year-old woman, tremendously distended by intestinal obstruction, was given a high anesthesia. The loss of the intercostals is little handicap to breathing ordinarily, but with the diaphragm already immobilized by distention it produced prompt respiratory failure followed by circulatory collapse.

There is some consolation in the fact that the accidents have not come to men with considerable experience in the use of pantocain and that a subsequent series of over 200 anesthetics have been given without a death. But two deaths, even in 800 cases, are two too many. In spite of this pantocain continues to be the anesthetic chosen by most of the staff when dealing with bad risks or shocking procedures.

Pantocain would be quite satisfactory if its administration could be consistently controlled so as to affect only the spinal roots selected for the operation

in question. A solution which would definitely favor the sensory roots and mix minimally with the spinal fluid appeals on theoretical grounds. We have been provided with a pantocain preparation of specific gravity 1.024. Its greater density assures sinking in any spinal fluid so as to puddle posteriorly and bathe the posterior roots. Its weight should also reduce to a safe level the tendency to mix with spinal fluid. Injected into the first lumbar space, for example, we would expect it to flow down the lower dorsal declivity and lie in the thoracic curve until completely taken up in the sensory roots with which it lies in contact. In the small series of anesthetics so accomplished it has seemed to justify our expectations.

On the whole we have found pantocain a satisfactory drug for spinal anesthesia. Its duration and lesser effect on blood pressure particularly recommend it. The present solution is not satisfactory for upper abdominal work in the hands of the inexperienced. "Heavy Pantocain" is a possible solution of our problem.

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DISCUSSION.—DR. CHARLES L. JANSSEN (New York) said that when novocain anesthesia was first used in the surgical treatment of carcinoma of the rectum by the abdominoperineal operation, it was thought to be a great improvement because with spinal anesthesia the abdominal stage of the operation was easier and more rapid. However, it was soon realized that in the length of time that novocain spinal anesthesia lasts, that is, one and one-half hours, it was frequently very difficult to do an operation as extensive as this in one stage. In 78 per cent of cases, it was necessary to supplement it with some general anesthesia. But with the advent of pantocain anesthesia, general anesthesia has been required, in addition, in only 25 per cent of cases, and in at least two of these it was not because the anesthesia had worn off but because the patients were excitable and complained of a great deal of pain in the shoulder region (as a result of the prolonged Trendelenburg position). In all cases operated upon under spinal anesthesia alone, whether novocain or pantocain, there has been no operative death. When general anesthesia has had to be combined with spinal anesthesia, especially with novocain anesthesia, the mortality has been as high as 31 per cent. In a group of 20 cases where pantocain has been used, including those requiring, in addition, general anesthesia, there has not been a death. In operative procedures which may require more than one hour, Doctor Janssen felt that pantocain as a spinal anesthesia is much more satisfactory than novocain.

DR. HENRY F. GRAHAM (Brooklyn) stated that, although not an anesthetist, he had given approximately 1,000 spinal anesthetics, including at first novocain and more recently one or two hundred pantocain anesthetics. As a result of the exercise of great caution in administering the anesthesia with a somewhat larger percentage of incomplete anesthesia than usual, no deaths had resulted to date. He concurred in the observation that pantocain is much more satisfactory than novocain.

Regarding the cause of death in spinal anesthesia, reference was made to the conclusions of Bower, Clark, Wagoner and Burns in an article in *Surgery, Gynecology and Obstetrics*, June, 1932. They summarized the clinical and experimental work in spinal anesthesia for a period of 11 years and concluded that death from spinal anesthesia was the result of the following series of events:

- (1) Drug paralysis of cardiac and respiratory nerves, including the phrenic and intercostal nerves;
- (2) Dilatation of the heart and respiratory embarrassment;
- (3) Cardiac dilatation and venous stasis in the great veins of the thorax and a later drop in arterial pressure;
- (4) Anoxemia caused by the fall in arterial pressure and diminished respiration;
- (5) Death.

These authors also found that, in general, artificial respiration was the only stimulation necessary to effect recovery, provided it was begun before the respiratory center had ceased to function and was continued long enough.

After hearing the work of these authors described, in 1930, he had an old pulmotor overhauled, including the installation of complete new tubing, removing the regular pulmotor tank because it was of an odd size and adapting the machine to regular small oxygen tanks for instant availability. This was kept in the anesthetizing room, adjacent to the operating room. Four years passed during which many hundreds of anesthetics were given without the necessity of using the pulmotor. Four months ago after injecting 18 mg. of pantocain under the third lumbar spine, the patient upon whom a hysterectomy was to be done stopped breathing. A suture was immediately passed through her tongue and within 60 seconds the pulmotor was placed over her face. The patient improved at once. Her pulse became strong. The hysterectomy was completed, and at its conclusion the pulmotor was removed, whereupon normal respirations commenced spontaneously.

In his opinion, the theory of the cause of death advanced by Bower, Clark, Wagoner and Burns is correct. Moreover, the instantaneous use of forced artificial respiration to reestablish the pumping action of the diaphragm will generally prevent spinal anesthesia death.

DR. CALDWELL B. ESSELSTYN (New York) said that during the past year pantocain was used in Presbyterian Hospital in 85 per cent of operations on the pancreas, 92 per cent of abdominoperineal resections, 84 per cent of spleens, 67 per cent biliary tract, 72 per cent intestinal resection exclusive of abdominoperineal resections, and in 82 per cent of the stomachs. The differences between pantocain and novocain are very real, profoundly influencing administration. First with regard to duration: In novocain the maximum duration is probably with 10 per cent solution, that is 100 mg. of novocain mixed with 1 cc. spinal fluid, or 200 mg. with 2 cc. given without barbitage. On the other hand, greater dilution does not divide the time proportionately. But if pantocain is diluted with an equal amount of spinal fluid, there is anesthesia for one and one-half to two hours, whereas if given undiluted without barbitage, it may run up to four or five hours. Halving the dilution practically doubles the duration of the anesthesia. Secondly, with regard to fixation: Novocain becomes fixed in the cord in a period of 10 or 15 minutes, after which time changing the position of the patient makes no difference in the fixation of the drug. In pantocain, however, fixation takes at least 20 to 25 minutes.

Its effect on the sympathetic nervous system is generally that it does not

drop blood pressure as much as does novocain; collapse of the bowel is not so profound, and those operated upon under pantocain have had to be catheterized in only one-twelfth the percentage of cases of those operated under novocain in spite of the major surgery which has been done under pantocain.

Pantocain can be given much more accurately than novocain, and because of this is especially desirable for certain operations. For instance, on the rectum, where 0.5 cc. or 0.75 cc. injected into the fifth lumbar interspace without barbitage, will produce spinal anesthesia limited to the perineum which will last four or five hours, without any drop in blood pressure. In producing anesthesia for inguinal herniorrhaphy the best results with pantocain are obtained when the tap is made opposite the nerve roots to be blocked. These are the eleventh and twelfth dorsal and upper second lumbar nerve roots. Therefore, the site of the tap should not be in the commonly selected third and fourth lumbar, but in the twelfth dorsal interspace or first lumbar at the lowest. In this way 1.5 cc. of pantocain, again given slowly and without barbitage, or 1 cc. of the drug diluted with 0.5 cc. of spinal fluid given similarly, will give the longest duration of anesthesia involving the operative field—the maximum length of postoperative comfort and the minimal physiologic disturbance to the patient.

It is in the upper abdominal operations that the most trouble is encountered. Although there are two types of abdominal operations allowing a comfortable incision up to the ensiform, but in one of these groups traction on the mesenteries gives no distress, while in the other it causes retching and vomiting. Study has shown that where anesthesia extended to the level of D₁-D₂, apparently there was traction without disturbance. So with pantocain the effort is made to stand way back at the twelfth dorsal or the first lumbar interspace and run the anesthesia up to D₁ or D₂ without any more control over it than the technic with which it is primarily given. The difficulty has come from the fact that the specific gravity of pantocain has been almost that of the spinal fluid, limiting thereby an intelligent control of the anesthetic by posture. Doctor Esselstyn had found a solution furnished by Dr. Hans Clark of help, but since a drug with a higher specific gravity is definitely of advantage in the upper abdomen, he had been using pantocain of a specific gravity of 1.024.

When given slowly pantocain does not diffuse to an appreciable degree; as evidenced by cell counts or lumbar taps 24 hours after it has been used, it is not irritating to the cord or cord membranes. Finally, by changing posture it has been possible to control the level of anesthesia in all cases. Using the solution mentioned, pantocain has proved safe for the upper abdomen if the patient remains level, and if the head from the lower cervical region up is put in a fairly marked cockup position. Furthermore, the anesthesia in this instance gravitates to the thoracic curve, giving the maximum amount of the drug opposite the nerves supplying the operative field.

It is felt that when spinal anesthesia is indicated, pantocain is the drug of choice; that the present stock preparations are satisfactory for lower abdominal but dangerous for upper abdominal work and that a solution of heavy pantocain is both safe and satisfactory for upper abdominal anesthesia.

DOCTOR BULL.—In answer to Dr. Erdman's question there certainly is a strong prejudice against the use of spinal anesthesia where the blood pressure is very high or very low. Our series includes cases of each type. Low pressures have been raised to reasonable levels and success-

fully maintained by infusion plus ephedrin. Fluctuations of blood pressure in hypertensives have been minimized by use of ephedrin. We have been much more courageous since adopting the improved technic in ephedrin administration. King, of Philadelphia, in the February issue of the *ANNALS OF SURGERY*, 1935, describes a measurement of cardiac reserve by means of a test dose of ephedrin on which he depends to prevent surprises. He also notes that in the presence of an apparent contra-indication to the use of spinal anesthesia it is often the anesthetic of choice, as inhalation anesthesia has even less to recommend it in some of these bad risks.

CARBON DIOXIDE ABSORPTION TECHNIC IN ANESTHESIA*

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APPRECIATION of the function of the lungs and the true physiology of respiration, which had for its foundation the discoveries of Priestley, Lavoisier and others late in the eighteenth century, opened the door for the introduction of inhalation anesthesia.

Over 100 years elapsed, however, before a complete understanding was current of all the changes that take place in the atmosphere during its entrance into and exit from the lungs. Oxygen was known to be lost while air was in the lungs and carbon dioxide to be picked up. The reason for the bad effect of "stale" air was not clear. In 1842, Leblanc studied the air of crowded assemblies and found that it contained 20 per cent oxygen. In 1849, Regnault and Reiset found by experimentation that oxygen in the inspired atmosphere could be reduced to 10 per cent before respiration was seriously embarrassed and that carbon dioxide decidedly in excess of the concentration found in overcrowded rooms was necessary to produce marked effect. The theoretical explanation then became current that "stale" atmosphere was poisonous because of the presence in the expired air of "poisonous volatile organic matter, probably protein in nature." Dubois Reymond gave this supposed substance the name "Anthropotoxin."

The existence of anthropotoxin was generally admitted until the twentieth century. Haldane, Fluger, Leonard Hill and others presented evidence against such a theory early in the century but in this country it remained for the New York State Commission on Ventilation to convince sanitary engineers as well as the medical profession of the mythical existence of anthropotoxin. Many reports of the Commission may be found in the literature following 1912. Their conclusions were that the air of crowded rooms was intolerable through the accumulation of heat and moisture and lack of movement, and not from the presence of anthropotoxin in the expired air.

The construction of inhalers for the vaporization and administration of anesthetic agents, from the discovery of anesthesia up to 1900, necessarily took into consideration the supposed existence of the fictitious toxin. The first ones, constructed by Morton in this country and Snow in Great Britain, aimed simply at delivering to the patient's air passages a vapor laden air which passed to the lungs and thence by a one-way valve to the room atmosphere. It was soon found that simple dropping of the volatile agent upon cloth held over the nose and mouth served the purpose. Vaporization in either manner necessitated the use of large quantities of the drug. In process

* Read before the New York Surgical Society, March 13, 1935.

of vaporization, heat was used and therefore a very cold atmosphere was inhaled, leading to irritation of the membranes and other undesirable effects. Control of dosage and management of resistant cases was difficult by these technics. Attempted improvements were represented in Great Britain by the Clover inhaler (1876) and its long series of modifications, and in this country by such inhalers as the Bennett and its modification by Coburn, Gwathmey and many others. Appreciation of the handicap of the cloth vaporizers was apparent in the development of inhalers such as the Ferguson, the Allis or the handkerchief cylinder and cone. In each of these a wall, surrounding the vaporizing surface tended to enclose and retain some of the expired atmosphere, and with it otherwise wasted anesthetic vapor, together with heat, moisture and carbon dioxide of the exhaled air. Both types of attempt at semi-closed inhalation of anesthetic vapors, the rubber bag and the wall surrounding the face and vaporizing surface resulted in some advantage and at the same time disadvantage. Advantage was evident in better control of dosage and saving in quantity of agent, together with a warm moist vehicle in which to inhale the anesthetic vapor. The disadvantage lay in a decided increase in breathing due to the accumulated carbon dioxide, and more important, a reduction in the oxygen content of the atmosphere inhaled. The disadvantage of oxygen deprivation so much outweighed the advantages of semiclosed methods that a return was made in many quarters to "open drop" technic with or without morphine premedication. "Open drop" was advocated by Prince about 1894 and the method came into common use in many large clinics. In European literature, the technic of Prince has been erroneously referred to as the Mayo technic. When oxygen became available, either compressed in high pressure cylinders or from oxygen generators, the addition of this gas through semiclosed inhalers of the Clover and Bennett type was commonly employed. Such inhalers with oxygen were utilized for the continuous administration of nitrous oxide gas as well as of volatile liquids. Even so, the temptation was always present to take advantage to the full of economy of agent, heat and moisture at the risk of too much carbon dioxide being reinhaled.

Early in this century, Haldane, Hill and Flack, Henderson and others studied the problem of carbon dioxide in respiratory atmospheres. Gatch applied their findings to the problems of anesthesia. He studied and practiced the rebreathing of anesthetic atmospheres, calling attention to the advantages of excess carbon dioxide and to its disadvantages. He appreciated the value of the warming effect of reinhalation.

In the year 1916, the following conditions obtained in regard to inhalation anesthesia.

(1) A completely open technic was known to result in a cold dry atmosphere being inhaled, resulting in irritation of membranes and resultant hyperactive breathing. Control of some patients was difficult or impossible. It

had also been noted that excess loss of carbon dioxide with such technic sometimes caused circulatory depression (ether shock).

(2) A semiclosed technic was as a rule less damaging to the patient but required much clinical judgment in its use. Respiratory movements were excessive due to retained carbon dioxide. Cost of gas anesthesia, though less than with completely open technic, was for many cases prohibitive.

(3) With all inhalation anesthesia, sweating was the rule, reduction of body temperature usual, annoyingly hyperactive breathing frequent, and operating teams were constantly exposed to high concentrations of agents used.

In 1916 Dennis Jackson of the University of Cincinnati demonstrated that by absorbing expired carbon dioxide in alkali, animals could be confined indefinitely in a closed space containing an anesthetic mixture. The only necessary addition to the mixture was, he found, sufficient oxygen from minute to minute to replace that used out of the mixture as it diffused into the blood from the animal's alveoli. He determined that there was no oxidation of the common anesthetic agents while in the body and practically no excretion, other than through the lungs. Jackson thus called attention to a fact which, when applied to clinical anesthesia, was destined to eliminate many of the unphysiologic side actions previously considered necessary accompaniments of inhalation anesthesia. With a completely closed respiratory system and the absorption of carbon dioxide, the vapor of agents such as ether could be inhaled in a warm and moist atmosphere. The body temperature of patients subjected to long periods of anesthesia need no longer be expected to become depressed. Irritation and stimulation of the respiratory tract was less, resulting in quiet breathing during operation. Reflex stimulation of perspiration from cold inhalations was less frequently seen, which, taken together with the maintenance of a completely moist atmosphere for inhalation, resulted in considerable reduction in invisible water loss during and following operations. Quieter respiratory activity resulted in a decreased amount of work being performed during anesthesia. With the resultant decreased demand for oxygen, a greater margin of safety was made available in anesthesia with certain gases. The technical difficulties of administration were, in the main, simplified. The quantity of anesthetic agents used was greatly reduced. The anesthetist no longer need choose one anesthetic agent for private patients and another for ward cases on the ground of a difference in cost. The atmosphere of operating rooms was no longer saturated with anesthetic gases and vapors. Fire and explosion hazards were thus greatly reduced and surgical teams found themselves free of the chronic effects of ether and other drugs.

Clinical Application.—The clinical application of Jackson's principle of carbon dioxide absorption is now being utilized by every manufacturer of anesthesia apparatus in this country. The mechanical details have varied. Early development of the technic was dependent on the availability of a

safe and efficient absorbing agent. Jackson's original experiments were done with sodium hydroxide sticks. Fortunately, at the close of the World War, Wilson was conducting experiments for the United States government in an attempt to produce an efficient absorber for use in gas masks. The result of these experiments, known as "Wilson's Soda Lime," has so far proved the most applicable to the needs of anesthesia. "Wilson's Soda Lime" consists of a mixture of calcium and sodium hydrate and a small addition of Kieselguhr in such proportions as to result, when properly prepared, in a granular material which does not deliquesce on exposure to exhaled air. The alkaline content does not go into solution in water of condensation. Some heat results from chemical reaction of the carbon dioxide with the alkali. Some water is absorbed by the soda lime. Gradual improvement in making soda lime more perfect has taken place since Wilson's work in 1921 and the manufacturers are engaged in further experiments in the hope of producing an absorbing agent with minimum bulk, dust content and heat production, with maximum capacity for absorption of carbon dioxide and maintenance of the most physiologic humidity of the inspired atmosphere. Two widely different mechanical solutions of the construction of a closed respiratory system are obvious.

Closed Respiratory Systems.—First, one may use a circle device in which the expired atmosphere is carried from a face mask through tubing leading to the absorber, thence to a breathing bag or spirometer and thence back through tubing to the mask. Somewhere along this circuit, an inlet is provided for the original filling of the system with anesthetic mixture and the constant addition of oxygen to replace that used from the mixture by the metabolic activity of the patient. This is the mechanical construction of apparatus for the determination of oxygen consumption from which metabolic rate is estimated. Although the construction of metabolism apparatus has, in many instances, depended on one-way valves for the assurance of the circulation of the respired atmosphere, in every case the manufacturer has eventually resorted to the use of an electric fan or pump to maintain circulation without effort on the part of the patient.

My own early experiments were attempts to reach a mechanical solution of carbon dioxide absorption in anesthesia in this manner. The difficulty of eliminating leaks under operating room conditions, the "load" to respiration of forcing atmosphere through tubing and one-way valves, and the undesirability of including an electric fan or pump when ether vapor and other explosive agents must be employed, led to its abandonment for routine operating use.

The second mechanical solution of a closed respiratory system, a direct or to-and-fro application, although it has not been applied to metabolism apparatus, has proved most satisfactory in our hands for use under operating room conditions in anesthesia. The arrangement is as follows: A canister of soda lime granules (4 to 8 mesh) contained in a cylinder (8 by 12 cm. inside dimension) is inserted between a face mask and small rubber breath-

ing bag (ten inch). Contact is made with mask and bag by means of metal tubing (2.8 cm. in diameter) in the form of easily connected and disconnected slip joints. The granules are held in place in the cylinder by means of a wire gauze dam at each end. A nipple is provided in the mask through which the closed respiratory system is filled during induction of anesthesia, and a constant measured flow of oxygen maintained at a rate of 200 to 400 cc. per minute throughout the administration. Since there is at present a likelihood that even the best soda lime may contain dust, forceful blowing through the canister before attaching it is essential until all dust is expelled. The use of a full size bed pillow for the patient is essential. Thus provided, and with the patient's head slightly turned to the right, the lower end of the canister rests on the pillow as the mask is fitted to the face, the bag extending over the end of the pillow and the side of the operating table. The presence of the breathing bag in the immediate vicinity of the head is considered a safety factor. It is readily visible and available for artificial respiration in an emergency. If excess carbon dioxide in the anesthetic atmosphere is indicated, the canister may be omitted, the slip joints serving to connect mask to bag directly. Rarely do we find the addition of carbon dioxide to anesthetic mixtures to be advisable during maintenance. The bag and mask without soda lime are, however, often used to hasten induction time with ether and to facilitate intubation for endotracheal anesthesia. We believe that the addition of carbon dioxide to anesthetic mixtures in open and semiclosed technics, the excessive employment of rebreathing, and the ill advised use of soda lime "cut outs" in closed technics have frequently resulted in physiologic damage and even fatality.

The everyday management of such a closed technic in the operating room has not been found arduous. An elastic retaining harness has proved useful in aiding the anesthetist's hand to maintain airtight contact of face and mask. Care must be taken to check breathing bags and apparatus periodically for leaks. The anesthetist should have a clear appreciation of the physiologic signs of oxygen want, carbon dioxide excess and overdose of the agents used. Frequent blood pressure readings are taken. A rising systolic pressure, not explainable on other grounds, and a gradually increasing hyperpnea give evidence of accumulating carbon dioxide, usually indicating that the absorptive property of the soda lime is becoming depleted. A canister of the size described above lasts usually not less than seven hours.

For work about the face and head, plastic and brain surgery, closed endotracheal airways are often substituted for the face mask, an adapter serving to connect the airway directly to the soda lime canister. Specially shaped masks are useful for certain operations. Holders for canisters in positions precluding the presence of the anesthetist in the vicinity of the head are shown. To make such positions safe, previous intubation should be done to avoid all danger of obstruction to the airway. The ease with which an anesthetized patient can be moved from one room to another should be noted. A quick addition of several hundred cc. of oxygen and the delivery tube may

be disconnected from the mask. Several minutes' interval may then safely intervene before connecting to the machine in another operating room.

Clinical Experience.—More than 15,000 administrations have been conducted with the completely closed or carbon dioxide absorption technic by my associates and myself. We have found it pleasant and convenient from the standpoint of anesthetist, patient, and surgeon. The hospital management has found it economical. In Tables I and II may be seen the percentage of postoperative morbidity and mortality at Wisconsin General Hospital for the years 1933 and 1934. 73.8 per cent of these cases were done with various agents administered by the carbon dioxide absorption technic.

TABLE I
Postoperative Morbidity

		Per Cent of Cases
Total cases (1933-1934).....	7,996	
Absorption technic.....	5,923	73.8
Respiratory:		
Major.....		1.2
Minor only.....		4.7
Circulatory.....		9.1
No nausea or emesis.....		70.3

We find the teaching of the underlying principles of anesthesia to be easier when using this technic than when older methods are employed. The student or intern without supervision may accomplish acceptable anesthesia somewhat sooner with open drop ether. However, with reasonably careful supervision, we are able to help senior students, serving a week in anesthesia, to do acceptable work with the absorption technic.

TABLE II
Postoperative Mortality

		Per Cent of Cases
Total cases (1933-1934).....	7,996	
Absorption technic.....	5,903	73.8
Total deaths.....	294	3.7
Respiratory causes.....		0.6
Circulatory causes.....		0.9
Anesthesia.....		0.05
Other causes.....		2.1

TIME OF DEATH

Oper. Day	1-3 Days P.O.	4-7 Days P.O.	2nd Week	Later
6.5%	17.7%	18.0%	16.2%	41.5%

The acquisition of a mastery of anesthesia in art and in practice, with a thorough appreciation of the underlying physiology and pharmacology, in-

volves for the average medical graduate an intensive training of not less than three years. We thoroughly believe that the knowledge and skill of the individual who administers an anesthetic drug is far more important than is the agent which he administers or the technic by which he administers it. The following statement was made by a prominent surgeon in regard to the care of brain injuries. "Changes in the patient's condition frequently appear so quickly and the period in which favorable action is possible is so brief that life may truly hang by a slender thread, the breaking or strengthening of which is dependent on the quality of the physician's care and skill. By quality is not necessarily meant specialists, but experts—those using the best clinical judgement (which is usually indicated by common sense) and the best technical ability." A patient with a brain injury enters the average hospital once in 20 days, whereas 20 patients in the average hospital have their brains and many other organs injured every day with anesthesia. When I first read the above quotation, it seemed to me that Walter Dandy must have been speaking of anesthesia.

Please do not therefore get the impression that the chemical absorption of carbon dioxide from anesthetic mixtures will revolutionize anesthesia. Only "the quality of the physician's care and skill" will do that.

DISCUSSION.—DR. JAMES T. GWATHMEY (New York) expressed the understanding that the fundamental idea of absorption technic is to keep intact the physiologic balance between respiration and circulation. But, he thought, the only way to approach this with an inhalation anesthetic is by means of preliminary medication in such a way that the patient is either unconscious or nearly so when brought to the operating table, terminal anesthesia—whatever it might be—being a supplementary measure. Very few institutions do this, however, although Willard Bartlett has been quite severely criticized for giving patients 15 gr. of luminal and morphine sulphate $\frac{1}{4}$ gr., so that they are asleep when they come to the operating table. This medication, however, quiets the patient for four, five or six hours after operation, and allows the tissues to react so as to bring the patient out in a completely analgesic state.

By preliminary medication the same effect is achieved as with carbon dioxide absorption, and without additional apparatus. But if increased relaxation—so desired by all surgeons in addition to safety—is better obtained with the absorption technic than without it, then this technic will be used by all whenever inhalation anesthesia is indicated. The only inhalant anesthesia, in Doctor Gwathmey's opinion, that keeps normal the balance between respiration and circulation is a new one, namely, cyclopropane. Since it does not seem to touch the respiratory center at all, it must certainly have a definite place in the future. Full credit, Doctor Gwathmey said, for the development of both cyclopropane and the absorption technic must go to Doctor Waters.

DR. E. A. ROVENSTINE (New York) thought that one advantage of the absorption technic which had not been brought out by Doctor Waters was its definite effect on respirations. Surgeons with considerable experience agree that in this type of anesthesia the respirations are more quiet and the degree of relaxation is as much as with other technics, giving the added advantage that the quiet abdomen offers in making operative conditions more nearly ideal.

DOCTOR WATERS (Madison, Wis.) called attention to the fact that one of the difficulties with open technic has always been the irritation of the cold vapor. The irritation of such drugs as ether is very much less when inhaled in a warm than in a cold atmosphere. The phenomenon of sweating after a cold drink of water taken on a hot summer day when one is not sweating may be a reflex sympathetic stimulus, but the same phenomenon occurs with inhalation in a closed system. The patients almost never sweat but remain dry to an extent that is impossible with open technics of inhalation. There is quieter respiration, as a rule, with the absorptive technic, possibly secondary to the warm atmosphere, and this results in a lessened use of oxygen, lessened muscular work, and, due to the lesser use of oxygen, provides a little more margin.

The advantage of premedication is to reduce the consumption of oxygen. Invisible water loss through the respiratory tract must be less with a constantly inhaled, completely moist atmosphere. This, combined with the lack of sweating and the almost complete elimination of the loss of water through the lungs, conserves water to a considerable degree.

In developing the absorption technic the quest was not simply to save money. The relative cost of anesthesia is not more important than the difference between a 20 and a 50 cent tube of catgut for the surgeon; results are essential. Certain agents should not be eliminated because they cost more. However, the necessity of deciding at times whether one should give a patient one anesthetic agent or another on the basis of cost is done away with entirely by the absorption technic.

The technical difficulties of the absorption technic are not very great; on the contrary, at the end of a month, during which it has been taught to the interns, better work is done by them with this method than with the open technic.

Additional advantages of the method are that it requires less care regarding the danger of fire and explosion, and, finally, it not only protects the operative team from anesthesia vapors, but eliminates the clinging odor of ether that is prevalent when one works all day by the open method.

Doctor Waters concurred with Doctor Gwathmey regarding premedication except that he felt it might be overdone. All nonvolatile agents when injected for premedication, he said, may cause respiratory depression and oxygen want. Hence it is best to stay at a safe dosage of premedication and add sufficient inhalation anesthesia, which is absolutely controllable.

PREANESTHESIA NARCOSIS WITH PARALDEHYDE*

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DURING the past eight months we have been interested in the development of some form of efficient preanesthesia narcosis which would be simple to administer, possess the greatest possible margin of safety, have a relatively transient effect upon the patient and be inexpensive.

We have, upon various occasions, achieved more or less satisfactory narcosis with sodium amytal, sodium phenobarbital, or tribromethanol. These drugs, though of unquestionable value in certain instances, have inherent drawbacks which make them undesirable for general use. The margin of safety of none of these drugs is very great, and their use is frequently attended by undesirable side reactions. Tribromethanol requires preparation by one with specialized knowledge, and demands a very definite technic in its administration. Moreover it is expensive.

With these things in mind, Dr. Chas. Gordon Heyd suggested the rectal administration of paraldehyde as a possible answer to these difficulties. Paraldehyde was introduced by Cervello in 1882, and has recently appeared in the literature as an obstetric analgesic, always coupled with sodium phenobarbital or sodium amytal. It is a polymer of acetic aldehyde, colorless, and has a characteristic pungent odor. It is soluble in water, miscible in certain oils, and possesses similar pharmacologic actions to alcohol, except for a marked accentuation of the hypnotic effect. One of the most desirable features of this hypnotic is its remarkable safety factor. Whereas the average dose is in the neighborhood of 20 to 25 cc., 100 cc. have been administered without serious effect other than the production of a prolonged sleep.

Over a series of some 50 odd unselected cases, the technic of administration has been developed as follows: The patient is weighed on admission to the hospital, and has usually been on bed rest for a varying period of time prior to operation. The night before operation the patient is given a cleansing soap suds enema, seldom a cathartic. One to one and one-half hours before operation the patient is turned upon his left side and the mixture containing about two tablespoonfuls of starch to a pint of water, to which has been added the requisite amount of paraldehyde is administered. This has been found empirically to be about 0.15 cc. per pound of body weight, although the dose may be varied within wide limits according to circumstances. Starch solution is used as the vehicle, because absorption of the paraldehyde from this solution is satisfactory, and it is more easily retained by the patient than oil. The total amount instilled into the rectum should not exceed six ounces, as patients are prone to expel larger quantities. One-

* Read by invitation before the New York Surgical Society, March 27, 1935.

half hour prior to the scheduled operating time, the patient is given a sixth of a grain of morphine, and 1/150 of a grain of atropine or scopolamine, depending upon the nature of the selected inhalant. This entire routine is carried out on the ward by the nurse in charge of the patient.

Approximately 15 minutes after the administration the patient falls into what is to all intents and purposes a quiet, natural sleep. He may occasionally appear to be awake, and may even give a more or less rational answer to a simple question if aroused, but on complete recovery he retains no memory of this, and shows in about 95 per cent of the cases a very satisfactory and desirable amnesia for all events subsequent to the instillation of the drug.

The patient's face is usually slightly moist and flushed; there may be either slight mydriasis or miosis, but the corneal and light reflexes are retained. Respirations are not affected except that they are quieter and more shallow, as in sleep. The blood pressure may show either a slight rise or fall, depending largely, we think, upon the previous psychic state of the patient. There is often a slight rise in the diastolic pressure, especially in thyroid cases. There is no marked diminution of the general bodily reflexes.

As a rule, these patients take an inhalation anesthetic well. The respiratory rate is generally slightly increased under the irritation of the inspired ether, as well as by the trauma of the operation. It should be noted, however, that if the preoperative morphine is given less than a half hour before operation, there is a depression of respiration by this drug on attempting to induce anesthesia; this is not a concomitant of the paraldehyde hypnosis. It is estimated, without any accurate quantitative determinations, that satisfactory anesthesia is obtained on approximately half the usual volume of the inhalation agent, be it either nitrous oxide or ethylene.

Recovery occurs two and one-half to four hours after administration, depending upon the amount given, and the nature and depth of the supplementary anesthetic. Paraldehyde is particularly advantageous for use with thyroid cases. The extreme hyperkinesis with which most of these patients come to surgery yields readily to this drug, and they are relieved of the apprehension and fear which they usually experience. Moreover, we feel that it is desirable for these patients to react shortly after the operation, so that the nature of the voice sounds may be ascertained before possible impairment by postoperative edema occurs. With proper timing and dosage, it is possible to arouse the patient sufficiently to have him speak a word immediately after leaving the operating room, although he does not remember this, and promptly falls asleep again.

With the use of paraldehyde we have noted no increased tendency toward operative bleeding, nor have there been any noteworthy postoperative complications in this series. Occasionally there is an increased postoperative restlessness, but this is easily controlled by morphine or one of the barbiturates.

The contra-indications are those of any general anesthetic. Paraldehyde

is excreted largely by the lungs, and may be noticed on the breath for about 24 hours after operation, but this is not unduly offensive. We feel that this drug should not be used in the face of hepatic or renal disease, colonic or rectal pathology, or parenchymatous lung affections.

PREOPERATIVE NARCOSIS WITH PARALDEHYDE
Condensed Chart Showing Relative Average Values

Average	Thyroids	Laparotomies	Miscellaneous
Age.....	39.2	44.2	44.2
Weight.....	136.7	135.7	123.0
B. M. R.....	25.1	—	—
Dose per lb.....	0.15 cc.	0.17 cc.	0.16 cc.
Total dose.....	23.9 cc.	22.8 cc.	21.2 cc.
Duration.....	2 hrs., 50 min.	3 hrs., 36 min.	3 hrs., 42 min.
B. P. a. Nar.....	152/73	132/84	138/92
B. P. p. Nar.....	142/82	122/81	120/82
Var. in resp.....	21	21	20
Amnesia.....	93%	92%	100%
Restlessness.....	2%	2.3%	2%
Inhalant.....	Ethylene	Nitrous oxide-ether	Ethylene nitrous oxide-ether

Our experience has been that this is an excellent agent for allaying the severe, though often unappreciated, psychic trauma attendant upon the anticipation of any surgical procedure. It is simple to administer, of very low toxicity, and as nearly foolproof as anything of this nature can be. It is inexpensive, and requires no elaborate testing, preparation, or apparatus for its administration. Pharmacologically it is satisfactory as a means of providing basal narcosis, and can be used as a preliminary in practically any case in which a general anesthetic is indicated. ~

SIMPLE DERMOID CYSTS OF THE BREAST

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THE term simple dermoid cyst is used to designate the epithelial lined cyst which occurs in the dermal and deeper tissues of the breast. In other localities, the term is sometimes used to describe tumors originating from incomplete closure of prenatal lines of cleavage which give rise to such complicated tumors that they are sometimes mistaken for teratomas. These complicated dermoids are most frequently seen in the regions of the neck and the coccyx.

The present study was made from 36 cases of dermoid cysts collected in approximately 3,000 breast lesions. The first case was recorded in December, 1900, and because many of the new as well as the old cases contained incomplete histories and microscopic sections, the statistics offered may be criticized as being inaccurate. However, the statistics were formulated from the complete cases alone and the percentages figured from such cases.

TABLE I

Cases: 36

Universal Symptom: Tumor

Benign		Malignant	
29 cases (81 per cent)		7 cases (19 per cent)	
(1) Average duration.....	3.9 yrs.	(1) Average duration.....	2.3 yrs.
(2) Average age incidence.....	47.7 yrs.	(2) Average age incidence.....	54 yrs.
(3) Sex distribution:		(3) Sex distribution:	
Female.....	100 %	Female.....	100 %
(4) Single cyst.....	73.1 %	(4) Cyst formation.....	42.9 %
(5) Multiple cysts.....	6.89 %	(5) Location:	
(6) Location:		Left breast.....	85.7 %
Right breast.....	40 %	Right breast.....	14.3 %
Left breast.....	60 %	(6) Dermoid	
(7) Dermoid cyst		(sole pathology).....	72 %
(sole pathology).....	45 %	(7) Dermoid plus benign breast	
(8) Dermoid cyst incidental to		pathology.....	14 %
malignant lesion.....	18.2 %	Plus malignant breast	
Incidental to benign le-		pathology.....	14 %
sion.....	36.8 %	(8) Infected dermoid.....	29.5 %
(9) Infected dermoid cyst.....	27.6 %	(9) Giant cells with dermoid ..	0
(10) Giant cells with dermoid		(10) Result: Two of seven cases	
cyst.....	20.7 %	dead: one from metas-	
(11) Result: No recurrence or		tasis, and the other	
malignant change		from unknown cause	

TABLE II
Synopsis of Case Records

Path. Number	Race, Sex and Age	Duration	Benign or Malignant	Clinical Impression	Location	Symptoms	Operation	Date	Result	Last Menstrual Period	Microscopic
49339	W. F. 40	6 mos.	Benign		Left breast	Trauma, pain, tumor	Excision tumor, 6-23-31		Well, 4-21-32		Cysts (multiple), mature squamous-cell lining, keratin, leukocytic and lymphoid infiltration
45962	W. F. 73	3 yrs.	Benign	Dermoid	Right breast, lower quadrant	Tumor	Excision tumor, 9-0-31		Lost		Cyst, immature squamous-cell lining, keratin
44858	W. F. 49	10 dys.	Benign		Left breast, left upper quadrant	Irritation, small tumor	Excision tumor, 4-2-31		Lost	2 wks previous to operation	Cyst, squamous-cell lining
14097	C. F. 47				Left breast	Tumor	Amputation breast, 9-29-28		Lost		Cyst (multiple), mature squamous-cell lining, keratin
40856	F.	2 dys.			Left breast	Pain	Excision tumor, 9-15-28		Well, 4-7-30		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
40640	W. F. 51	1 yr	Benign	Infected dermoid cyst	Left breast, right lower quadrant	Tumor, pain, irritation	Excision tumor (euteury) 7-3-28		Well, 9-10-28	Menopause	Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
42316	F. 57	2½ mos.	Benign	Dermoid		Tumor (gradual growth), pain	Excision tumor, 3-27-28		Lost		Cyst, squamous cell lining
39674	F.	18 mos.	Benign	Keloid			Excision tumor, 12-0-27		Lost		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
38686	F.						Excision tumor, 12-20-26		Well, 10-28-29		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
36098	F.				Left breast	Tumor	Excision breast, 8-17-25 Excision malignant dermoid of abdominal wall		Lost		Cyst, squamous cell lining
*35031	W. F.	1 mo.			Left breast, lower quadrant	Abscess, tumor	Excision tumor, 10-13-24		Well, 8-16-30		Cyst, malignant squamous-cell lining (multiple), keratin, lymphoid and leukocytic infiltration
35496	F. 47	3 yrs.	Benign	Dermoid	Left breast, upper quadrant		Excision tumor, 6-16-24		Well, 9-15-27		Cyst, squamous-cell lining, infiltration of leukocytes and giant cells
34496	F. 53	1½ da.?	Malignant	Carcinoma		Pigmented, warty mole, tumor (adherent and dangling) pedunculated	Excision tumor, 1-7-24 (complete)		Well, 11-4-27	Menopause 8 yrs. ago	Cyst, squamous-cell lining
*32515	F.						Excision tumor, 7-15-22 (complete)		Well, 1-11-28		Malignant squamous-cell lining (cyst formation)
32360	W. F. 53	5 yrs.			Right breast, upper, outer quadrant	Small firm mass, painless	Excision tumor, complete		Well, 1-0-28	Menopause at age 53	Cyst, squamous-cell lining (immature), keratin
31752	F.				Left breast				Lost		Cyst, squamous-cell lining

BENIGN DERMOID CYSTS

Clinical Features.—The cyst is usually subcutaneous, of variable size, sometimes hard, regular, circumscribed, freely movable, and usually painless. It occurs in the right and left breasts with approximately the same frequency. In the present series, 60 per cent of these tumors developed in the left breast. The average duration is 3.9 years, while the average age incidence is 58 years. Single cysts, as compared with multiple cysts, are found in approximately three-fourths of the cases. Unless the cyst develops to a noticeable size or becomes infected, it is often overlooked. In the present series, dermoid cyst was secondary to other pathology and, therefore, an incidental finding in 55 per cent of the cases. Thirty-three per cent of this number occurred in conjunction with malignant growths, while 67 per cent were incidental to benign lesions. The incidence of infection was found in approximately one-fourth of the cases. A small percentage of the histories showed evidence of infection, but because they did not have the corresponding microscopic sections, they were not classed as infected dermoids and for this reason the author thinks that the incidence of infection is higher than 28 per cent. The presence of infection gives the appearance of an abscess, but the history of a tense, doughy or slightly fluctuant mass being present and symptomless for weeks, which suddenly became inflamed, painful, tender and fluctuating, would readily rule out an ordinary abscess.

Gross Pathology.—These tumors are circumscribed, usually round, smooth-surfaced, and of varying size. The color and consistency vary with their contents. However, as a rule, they are grayish and moderately firm. When infection occurs they produce a reddening of the overlying skin and are themselves represented by a necrotic, cystic mass, walled off by a dense wall of fibrous tissue. The appearance of such infected tumors at operation may so closely resemble malignancy that even though a diagnosis of infected dermoid cyst is made clinically, a radical amputation of the breast is performed.

Microscopic Pathology.—Histologically, the lining of a dermoid cyst maintains epithelium which is identical to that of the normal skin. The proliferation of the squamous epithelium with keratinization is often seen together with an occasional papillary projection of the squamous-cell element within its lumen. The epithelial pegs, which are typical of the skin, are frequently found as a part of the outer wall of the cystic cavity. Occasionally keratin cysts may be seen in the wall of the dermoid. The derma, which may or may not be present, is difficult to distinguish from the normal subcutaneous tissue.

The association of sebaceous glands with dermoid cysts is frequently noted, and the relation between the two is probably an intimate one. The approximation between the sebaceous glands and dermoid cysts is so complete that the glands are seen emptying into the cystic cavity and in some cases seem to arise from a metaplasia of the same type of cell which developed the epithelial lining of the dermoids. The opening of the sebaceous

glands into the cyst explains the presence of grumous material which is often seen within its lumen. However, with the exception of the infrequent presence of calcium, keratin, the result of a normal physiologic process in squamous cells, is the most frequent material found in dermoid cysts.

Infection seems to be prevalent in dermoids. Whether the cause originates from trauma alone, or from a lowered resistance to the part produced by a pressure ischemia, or whether the close approximation of the skin and sebaceous glands offers an ideal portal for the entrance of bacteria, is debatable.

The presence of severe infection is usually characterized by an ulceration of the cyst wall following an infiltration of the acute and chronic cells of inflammation, namely, polymorphonuclear leukocytes, lymph, plasma, and epithelioid cells, eosinophiles and giant cells. The giant cells are present in approximately one-fourth of the dermoid cysts. Sometimes the infection is so severe and extensive that mere shreds of epithelium are left behind (Path. No. 40856 and Path. No. 40640). Round-cell infiltration permeated by a few giant cells may be seen in the pericystic stroma (Path. No. 35495). This pericystic infiltration with the presence of giant cells leads one to believe that the tissue in the region of the dermoid is prone to infection, principally because of lowered tissue resistance. The relative frequency of giant cells creates the possibility of a chemotactic action produced by the cells of the dermoid cysts.

MALIGNANT CHANGE

As in all epithelial tissue, the lining of dermoid cysts is subject to malignant change. Such a change may be so gradual that it is usually overlooked clinically and recognized only with difficulty under the microscope. Malignancy occurs in 19 per cent of the dermoids. The average duration of these tumors is 2.3 years. They occur practically always in the female breast and are usually on the left side; they are seen most frequently at 54 years of age. These dermoids are associated with benign breast pathology in 14 per cent of the cases. When malignancy becomes apparent, it is noted that the cyst wall has a tendency to grow rapidly with the formation of new cysts, or pearly bodies (Path. No. 26149 and Path. No. 35934). However, the growth is usually irregular, widespread (Path. No. 21383, Path. No. 8708, and Path. No. 5252), and has a tendency towards cyst formation in 42.9 per cent of the cases. As the degree of malignancy progresses, the tendency towards cyst formation decreases and in the Grade IV type, the pathologic picture is represented by a disorderly arrangement of embryonic epithelial islands which infiltrate through the surrounding tissue (Path. No. 8708 and Path. No. 5252).

It is possible for malignant change to be so completely hidden by the signs of a superimposed infection that the clinical diagnosis is difficult and, at times, impossible to make. Although no such case was found in this series, mild infections were seen in a small percentage of the cases.

Grossly, these tumors are firm, irregular, infiltrating, and have a tendency to metastasize early.

Microscopic Pathology.—Microscopically, the epithelial cells, as compared to the normal, become larger, more vesicular, hyperchromatic, and have a tendency towards pearl formation. The epithelial pegs dipping down into the derma, frequently breaking through the basement membrane, are more prominent and irregular. Adjacent epithelial islands and cysts, resembling exaggerated epithelial pearls, are sometimes seen. Keratin may be found, but as the degree of malignancy increases, the tendency towards keratin formation decreases. As the tumor becomes more malignant, the epithelial tissue grows more profusely, forming epithelial islands with only an occasional cystic arrangement. This growth progresses to the extent that its latter stages of development cannot be distinguished from any form of malignant infiltrating squamous-cell carcinoma (Path. No. 21383). The absence of giant cells in the malignant dermoids of the present series indicates the rarity with which they are encountered.

Infection may complicate malignancy and if extensive enough may obliterate the morphology of cancer cells. However, when malignancy is present and a proper section of the tissue examined, a correct diagnosis can be made in a great majority of cases.

Discussion.—The origin of the simple dermoid cyst is questionable. Congenital misplacement of epithelium is the explanation offered by Remack¹ and Heschl.² Reverdin³ stresses the importance of implantation of epidermal fragments by trauma. In a small percentage of cases such an origin seems likely, although no case in the present study gave such a history. The origin may be explained by misplaced germinal centers which result either as a congenital or a postnatal anomaly stimulated by some intrinsic, or possibly extrinsic, source which governs the normal skin. Since isolated groups of epithelial cells have a tendency to keratinize, a concentric arrangement and desquamation of keratin explains the cyst formation.

Retention cysts are frequently confused with dermoids and in some cases they are indistinguishable. However, the retention cysts are usually recognized by their lining cells which are composed of compressed epithelial cells rather than the typical epithelial cells lining dermoids. The possibility of the migration of a retention cyst of the skin to the subcutaneous tissues has been shown by Chiari.⁴ The invagination of skin epithelium into a bottle-shaped structure with the narrow lumen of the epithelial growth sealed with keratin may so mimic a dermoid cyst that it is sometimes mistaken for one. Such a case was found among the sections of the laboratory. Caution should also be used in diagnosing cross-sections of inverted nipples for in many respects they closely resemble dermoid cysts.

The presence of a round, circumscribed, smooth, tense and sometimes fluctuant, movable, subcutaneous lesion of the breast should always arouse the suspicion of a dermoid cyst. A history of these findings occurring for a long period with a sudden development of abscess symptoms should im-

mediately bring to mind the possibility of an infected dermoid (Path. No. 40640, Path. No. 16558, *etc.*). However, even though infected dermoid cysts are diagnosed clinically, they may resemble carcinoma so closely at operation that the surgeon performs an unnecessary mutilating radical amputation of the breast. Even though dermoid cysts are rare (36 cases in approximately 3,000 breast tumors), they should always be borne in mind, and above all, they should be remembered as being potentially malignant, for this change is seen in 19 per cent of the cases. The aid of transillumination, popularized by Cutler,⁵ should, as in all breast lesions, be employed, for it is the most reliable method of clinically distinguishing a cystic from a solid mass.

The treatment of dermoid cysts is best carried out by a local excision of the cyst followed by immediate microscopic study of the tissue removed. It is felt that if a dermoid cyst, proved by biopsy to be benign, is not totally removed, the possibility of recurrence, sinus formation and malignant change is too great to advise a less radical procedure. Two cases, Path. No. 30605 and Path. No. 28945, presented draining sinuses from improper treatment.

If the frozen section of the cyst proves malignant, a radical amputation of the breast should be performed.

Irradiation is valueless in malignant dermoid cysts for the cells are of the squamous (radio-resistant) variety.

CONCLUSIONS

(1) Dermoid cysts of the breast are believed to arise from misplaced basal epithelial cells (germinal centers) which are stimulated to activity by intrinsic and possibly extrinsic sources.

(2) The close association of sebaceous glands to dermoid cysts is emphasized. They are believed to arise from the same type of epithelium producing the dermoid cysts.

(3) Dermoid cysts of the breast are rare. Thirty-six cases were found in approximately 3,000 breast tumors.

(4) Eighty-one per cent of the dermoid cysts are benign, while 19 per cent are malignant.

(5) Dermoid cysts occur practically always in females. They also usually occur as a single lesion and are most frequently located in the left breast.

(6) The average age incidence and duration of symptoms of benign dermoids are 47.7 years and 3.9 years, respectively; in malignant growths they are 54 years and 2.3 years respectively.

(7) Benign dermoids are associated with other breast pathology in 55 per cent of the cases, while the malignant dermoids are similarly associated in only 28 per cent of the cases.

(8) Benign dermoid cysts are best treated by total excision of the tumor mass, while malignant dermoids are best treated by radical amputation of the corresponding breast.

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TUBERCULOSIS OF THE BREAST

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DURING the past decade a great plea has been made for the coöperation and combined treatment of certain medical problems, by both internist and surgeon. There is no question that such teamwork has been of material benefit to patients suffering from diabetes, thyroid and cardiac affections, peptic ulcers, and in more recent times, pulmonary tuberculosis. Such an opportunity presents itself in the management of tuberculosis of the breast.

History.—Tuberculosis of the breast was first recognized as a clinical entity in 1829, when Sir Astley Cooper¹ described the macroscopic features of a “scrofulous swelling of the busom.” Dubar,² in 1881, was the first to establish the diagnosis upon a microscopic and bacteriologic basis. Ohnacker,³ in 1883, was the first to report the successful transmission of the disease to animals.

Morgen,⁴ in 1931, reviewed the literature and recorded 439 cases, of which 238 were primary and 157 secondary. He reported six additional cases. Since the publication of this paper 34 other cases⁵ have been reported.

When compared with the frequency of tuberculosis occurring in other organs of the body, tuberculous mastitis is relatively uncommon. From 1923 to 1933, 623 cases of diseases of the breast were admitted to the Jewish Hospital of Brooklyn. Of these 392 were tumors, of which ten were tuberculosis of the breast (1.4 per cent of all breast cases). In addition the hospital records show two cases in 1921.

Tuberculous mastitis may be classified clinically as primary and secondary. In the primary type the disease is confined to one breast, with or without involvement of the axillary nodes of the same side and there is no clinical evidence of active tuberculosis elsewhere. In the secondary type, there are manifestations of active tuberculosis in other organs, especially the lungs, pleura and ribs.

Considerable controversy exists regarding the manner in which the disease is contracted. Several explanations have been advanced.

(1) *Direct inoculation of the breast* through the abraded surface of the nipple or skin by way of the skin lymphatics; it is rarely conveyed through the milk ducts. Deaver⁶ limited the primary cases to this group.

(2) *Secondary inoculation of the breast* takes place by contiguity, through the blood stream or through the lymphatics.

Tuberculosis involving the breast by contiguity has been reported in several cases, the primary lesion being in the pleura, sternum or ribs. Most writers believed that the most probable route of extension was through the

blood stream. However, Nagaskima⁷ in 1925 definitely disproved this contention. He reported the autopsy findings of 34 cases of miliary tuberculosis, where careful sections of each breast had been taken. The breast was found to be the only organ free from evidence of tuberculosis. He concluded, therefore, that hematogenous infection of the breast occurs rarely, if ever. Morgen agrees with Deaver's conclusion that retrograde extension through the lymphatics is the most probable mode of infection. Morgen emphasizes the fact that the majority of people become infected with tuberculosis. The bacilli, however, may remain dormant in the tissues for some time. With lowering of local resistance in some particular part of the body, the tubercle bacilli are again liberated, and reach the breast through the lymphatic channels, probably by retrograde embolic processes (Deaver). The most important primary foci are the hilum, axillary, cervical and retrosternal lymph nodes.

Etiology.—Of the few cases where cultural identification of the tubercle bacillus was determined, the bovine type alone was found (Barker⁸). However, the number of these cases is too small to warrant conclusions. The cases are not limited to females; Morgen collected 20 cases occurring in males; four more have since been reported.^{5b, n, r, t} A history of trauma was elicited in seven per cent of Morgen's cases and in two of the cases to be presented. A variance exists in the statistical reviews regarding age predilection. In Morgen's series, the greatest age incidence was between 20 and 40; in Deaver's, between 30 and 50; in Kaufmann's,⁹ between 40 and 68. In our series, two cases occurred at 26, the others ranged from 33 to 53. Most of the cases occurred in married women who had borne children.

Pathology.—Tuberculosis of the breast is usually unilateral. The macroscopic appearance varies. Isolated or scattered foci of grayish-yellow granulation tissue appear, with associated caseation or suppuration and fibrous induration. The pathologic changes may be divided into three groups:

(1) *The Nodular Type* (discrete, disseminated and confluent).—The discrete nodular type occurs most frequently. The tubercle is usually situated in the connective tissue, rarely in the duct or periductal tissue. The acini are destroyed by the reactionary lymphatic infiltration. The tubercle enlarges, usually slowly, to form a mass varying in size from a small marble to a hen's egg; it rarely becomes larger. Caseation takes place, and if suppurative softening occurs, sinuses are formed. Daughter tubercles form at the periphery of the area in the disseminated type. In the confluent type liquefaction necrosis takes place in several of the tubercles and these caseous suppurative masses communicate with each other in various directions through fistulous tracts.

(2) *The Sclerosing Type.*—This type occurs in older people. It is characterized by chronicity; this allows of ample time for protective fibrosis to occur. As in fibroid phthisis there is a diffuse epithelioid and embryonic connective-tissue infiltration. The breast in its terminal stage is small, hard and shrunken.

(3) *Atypical Forms*.—The rarer forms are included in this group. (a) *Obliterating tuberculous mastitis* (obliteration of the ducts) has been described by Ingier.¹⁰ (b) *Intraglandular cold abscess* represents an advanced stage of the confluent nodular type, where deep-seated suppurating masses are present.

Tuberculosis may be present in association with other conditions of the breast; notably adenoma, fibro-adenoma and carcinoma. Lee and Floyd¹¹ collected ten cases with co-existing adenoma and seven with carcinoma. Recent literature cites three more cases occurring with carcinoma.^{5c, f, 1}

Diagnosis.—In eight of the 12 cases to be described the appearance of a nodule in the breast was the initial complaint. Pain occurred early in four of the cases; it was invariably present during the stage of suppuration. A thin purulent discharge from the nipple appeared in two of the cases. The duration in our series ranged from two weeks to seven months. Vandell¹² in his group of cases found the average duration for the primary cases 10.1 months; and from 11.2 to 12 months for the secondary cases.

Physical examination in most cases revealed no gross impairment of health. In only one of the 12 cases—the only secondary case—was there evidence of a marked loss of weight. The findings in the primary group were limited to the breast. The right one was somewhat more frequently involved than the left (seven of the 12 in our series and 204 of the 379 cases in Morgen's series). The lower quadrants were more frequently affected in our series. Early, a discrete, slightly tender nodule was noted. This either remained the same in size or became gradually larger, with the development of contiguous nodules. During the stage of liquefaction necrosis, tenderness increased and fluctuation was elicited, at which time the skin became adherent and showed signs of inflammation. With ultimate rupture of the skin, a sinus formed, and thin pus was discharged. Where the nodule was close to the areola, retraction of the nipple took place. The axillary lymph nodes were frequently enlarged (25 per cent of our series; and in Deaver's, 9 per cent of the primary, and 75 per cent of the secondary cases).

Differential Diagnosis.—Tuberculous mastitis must be differentiated from:

(1) *Tumors*: fibroma, fibro-adenoma, sarcoma, and carcinoma. Carcinoma was the most frequent preoperative diagnosis in most of the cases that were operated upon (three of the 12 cases in our series). The differentiation is important, because less radical measures than are usually necessary in carcinoma effect a cure in tuberculous mastitis. A diagnosis based on frozen section examination of all doubtful cases should be made at the time of operation. Sarcomata are rare, and are characterized by their rapid growth.

(2) *Pyogenic Mastitis*.—As a rule acute suppurative mastitis offers no problem in differential diagnosis. In subacute and chronic cases, histologic and bacteriologic examination is the only means of recognition.

(3) *Other Infectious Granulomata*.—Gummata of the mammary gland (mastitis gummosa) are very rare. They are characterized by their chronic-

ity and extensive ulceration; when healing begins, deep retracting scarification results. Actinomycosis is extremely rare; it may be secondary to actinomycosis of the pleura and the lungs; Kaufmann⁹ reported one case and referred to four others. The ray fungus is to be sought for in the discharge.

The prognosis is unusually good in tuberculous mastitis with proper treatment. The occasional postoperative recurrence was limited to the secondary group.

Treatment.—(1) *Surgical.*—All the cases reported thus far in the literature were operated upon, since the accepted treatment is surgery. Where the condition is localized (discrete nodular variety), simple excision is all that is necessary. Where the involvement has become more widespread, a simple mastectomy should be performed. Radical mastectomy is never necessary. The accompanying lymph-node enlargement may receive roentgen therapy, heliotherapy, or surgical removal.

(2) *Nonsurgical Treatment.*—Von Eberts¹³ in 1909 suggested that early in the course of tuberculosis of the breast, where the disease is discrete and the patient is in good health, one is justified in postponing operative intervention until the effect of a course of tuberculin treatment has been tried, in conjunction with good hygienic care.

Case XII presented an opportunity to determine the efficacy of medical treatment. A biopsy of one of the nodules disclosed the tuberculous nature of the lesion, and guinea-pig inoculation confirmed this diagnosis. From December 7, 1933, and for the subsequent four weeks the patient received tuberculin (O.T.) by inunction. In addition she received ultraviolet irradiation up to the erythema dose. Treatments were given at four-day intervals. The first effect noted was cessation of the discharge from the sinuses. There was a progressive decrease in the size of the nodules. By the end of the fourth week, the nodules could no longer be felt, the patient's general health had improved and she had gained nine pounds. Although she had been urged to continue treatment for several months, the patient felt quite well and discontinued further treatment. She remained in good health for the next seven weeks. She then received a slight blow on her right breast. Within a week pain and swelling of the lower half of the right breast appeared and a mass the size of an orange was felt. The pain and tenderness were exquisite. Although a return to medical treatment was advised, because of the severity of the pain the patient insisted upon removal of the breast.

CASE REPORTS

CASE I.—No. 66064. Mrs. B. F., married, aged 37, mother of two children. Admitted to the hospital April 2, 1921. Eight weeks before admission, she left the hospital after the breast was incised for an abscess. At that time a small amount of pus was obtained. A thin purulent discharge has continued ever since. A few weeks later, two lumps appeared contiguous with the abscess. Pain was not present. Physical examination revealed the patient in good health and the heart and lungs normal. The left

breast, lower inner quadrant, presented a linear incision from which a thin pus exuded. An ulcer, the size of a dime, was present at the outer edge of the areola. Two hard, nodular masses, each the size of a hen's egg, were found contiguous to the incision. These nodules were tender. No axillary nodes were felt. *Operation*: simple mastectomy. *Pathologic report*: tuberculous mastitis.

CASE II.—No. 68551. Mrs. M. S., married, aged 44. Admitted to the hospital September 21, 1921. Two and one-half months previously she was kicked in the right breast. A few days later she noticed a slight swelling in that breast, and this has continued to increase. Pain was not present. Examination revealed a woman in good health, heart and lungs normal. A firm, hard, nontender mass, the size of an orange, was found in the lower outer quadrant of the right breast. Roentgen ray of the lungs disclosed no abnormality. *Operation*: simple mastectomy. *Bacteriologic findings*: negative. *Pathologic report*: tuberculous mastitis.

CASE III.—No. 69808. Mrs. F. M., married, aged 47. Entered the hospital December 13, 1921. Six months before admission she noted a small nodule in the right breast. The condition remained unchanged until one week previously, when it began to enlarge and become painful. Examination revealed a woman in good health, heart and lungs normal. A mass, the size of a plum, tender and fluctuant, was found in the lower inner quadrant of the right breast. The skin over the mass showed signs of inflammation, but was not adherent. The lower outer quadrant presented a small nodular mass which was not tender. *Preoperative diagnosis*: carcinoma of the breast. *Operation*: radical mastectomy. *Pathologic report*: chronic inflammatory lesion characterized by connective-tissue replacement. The mass is infiltrated by plasma and round cells. Considerable epithelioid proliferation is present. An occasional giant cell is seen. There are many areas of caseation necrosis. *Impression*: tuberculous mastitis.

CASE IV.—No. 77036. Mrs. S. G., married, aged 26, mother of two children. Entered the hospital February 23, 1923. Three months ago she noticed a lump in the left breast; it has since become larger and painful. Examination revealed a well-developed woman, apparently in good health. Several small nodules, each the size of a marble, were found in the lower outer quadrant of the left breast. The skin over some of the nodules showed signs of inflammation; tenderness was marked. *Operation*: simple mastectomy. *Bacteriologic report*: many acidfast bacilli present. *Pathologic report*: many tubercles are seen; they are characterized by the presence of collections of epithelioid cells and many giant cells. Many areas of caseation necrosis are seen. There is an increase in fibrous tissue. *Impression*: tuberculous mastitis.

CASE V.—No. 77939. Mrs. S. S., married, aged 33. Entered the hospital April 8, 1923. In January, 1923, the right breast was incised and drained. The discharge persisted; and six weeks later a section was removed for pathologic study. For a few weeks before admission to the hospital, she noticed nodules in the right breast; they have become larger and more painful. Examination revealed a woman apparently in good health, heart and lungs normal. Three incisional wounds discharging a thin pus were found in the lower inner quadrant of the right breast. A small mass, the size of a walnut, was palpated. It was hard and tender and not adherent to the skin. *Operation*: simple mastectomy. *Pathologic report*: evidence of chronic inflammation, with considerable fibrosis and marked destruction of the parenchyma is noted. Also, there are to be seen, areas of tubercle formation with perivascular round-cell infiltration, giant cells and areas of necrosis. *Impression*: tuberculous mastitis.

CASE VI.—No. 78696. Mrs. E. S., married, aged 42. Entered the hospital May 22, 1923. Two weeks before admission she noticed a hard mass in the right breast. She felt a drawing sensation, but no pain. Examination revealed a woman apparently in good health, heart and lungs normal. A hard and tender mass, the size of a plum, and not attached to the skin, was found in the inner, lower quadrant of the right breast. *Preoperative diagnosis*: carcinoma of the breast. *Operation*: radical mastectomy. *Pathologic*

report: microscopic examination shows the presence of a diffuse chronic inflammation. Many epithelioid and round cells are found in the arrangement characteristic of tuberculous lesions. Fibrosis is also noted. *Impression*: tuberculous mastitis.

CASE VII.—No. 86627. This case illustrates the only true secondary type of involvement in our series. Mrs. E. S., married, aged 37, mother of three children. Entered the hospital August 12, 1924. Four weeks before admission she had pain in her left breast and noted the presence of a small mass. Examination revealed a mass, the size of a marble, in the lower outer quadrant of the left breast. A thin serous discharge issued from the nipple. Tenderness was not elicited, and the mass was not adherent to the skin. The general condition of the patient appeared good, but examination of the chest disclosed significant findings: bronchovesicular breathing and inspiratory crepitant râles over both apices. *Operation*: simple mastectomy. *Pathologic report*: the mass shows the presence of inflammatory reaction with many plasma cells and several giant cells. Considerable fibrosis and many epithelioid and round cells in typical tubercle formation are seen. *Diagnosis*: tuberculous mastitis.

CASE VIII.—No. 118075. Mrs. E. S., aged 44, married, mother of seven children. Entered the hospital January 29, 1929. Three weeks before admission she noticed a discharge from the left nipple. Two weeks later, the left breast became swollen, hot and painful. Examination revealed a woman apparently in good health, heart and lungs normal. Roentgen ray examination of the chest disclosed no abnormality. A large red area was found around the nipple of the left breast. The nipple was small and retracted and beneath it a large, circumscribed, tender mass, the size of a hen's egg, was felt. A few nodes were palpated in the axilla and in the supraclavicular region on the left side. *Operation*: excision of mass. *Pathologic report*: sections of the breast show numerous tubercles, with epithelioid and giant cells. Areas of necrosis and hyalinization are noted. *Impression*: tuberculous mastitis.

CASE IX.—No. 136099. Mrs. R. S., aged 36, married, mother of three children. Entered the hospital January 29, 1931. The patient stated that she had not been feeling well for some time, and had lost considerable weight. Nineteen months before admission, she noticed her left breast getting larger. Four months later she felt a mass in the breast. Examination revealed a patient who had apparently lost considerable weight; the heart and lungs showed nothing abnormal. A tender, irregular, nodular mass, the size of a hen's egg, was found in the lower outer quadrant of the left breast. The mass was not adherent to the skin, but the nipple was retracted. A few nodes were palpated in the left axilla. *Operation*: resection of mass, partial mastectomy. *Pathologic report*: several masses of breast tissue, containing cystic areas and lined by a gray necrotic membrane are seen. On section, these masses are made up of pearly-gray tissue containing a few nodules. No tubercle bacilli were found. Microscopic examination shows the presence of a diffuse chronic inflammation, characterized by a diffuse round cell infiltration and a collection of epithelioid cells arranged in the manner, characteristic of tuberculosis. An occasional giant cell is seen. *Impression*: tuberculous mastitis.

CASE X.—No. 147968. Mrs. R. K., aged 36, married, mother of three children. Entered the hospital March 28, 1932. The patient noticed a small painful nodule in her right breast. Examination revealed a patient in good health, heart and lungs normal. A small tender nodule, the size of a marble, was found in the upper, outer quadrant of the right breast. Axillary nodes were not found enlarged. *Operation*: partial mastectomy; wide excision of mass. *Pathologic report*: the mass is yellowish-gray in color and of soft consistency. On section it is found to be granulomatous in nature; it is infiltrated with round cells and a few polymorphonuclear leukocytes and plasma cells. A large number of epithelioid cells are present and many giant cells are seen. There is a considerable degree of fibrosis as well as central necrosis. The inflammatory process extends along the lymphatics and enters some of the neighboring acini. *Impression*: tuberculous mastitis.

CASE XI.—No. 161571. Mrs. M. S., aged 53, mother of seven children. Entered the hospital July 5, 1933. Seven weeks before admission she noticed swelling of the right breast, and the appearance of a painful mass. Examination revealed a patient in good health, heart and lungs normal. An irregular, tender mass, the size of a lemon, was found in the upper, inner quadrant of the right breast. It was not adherent to the skin. A few nodes were palpated in the right axilla. *Preoperative diagnosis*: carcinoma of the right breast. *Operation*: radical mastectomy. *Pathologic findings*: section shows the mass to consist of multiple tiny cysts, clogged with an inspissated, clay-colored fluid. The structure is definitely granulomatous, consisting of many round, epithelioid and giant cells; some fibrosis is present. *Impression*: tuberculous mastitis.

CASE XII.—No. 165214. Mrs. F. M., aged 26, married, mother of two children. Admitted to the hospital on our service, November 21, 1933. Twelve weeks before

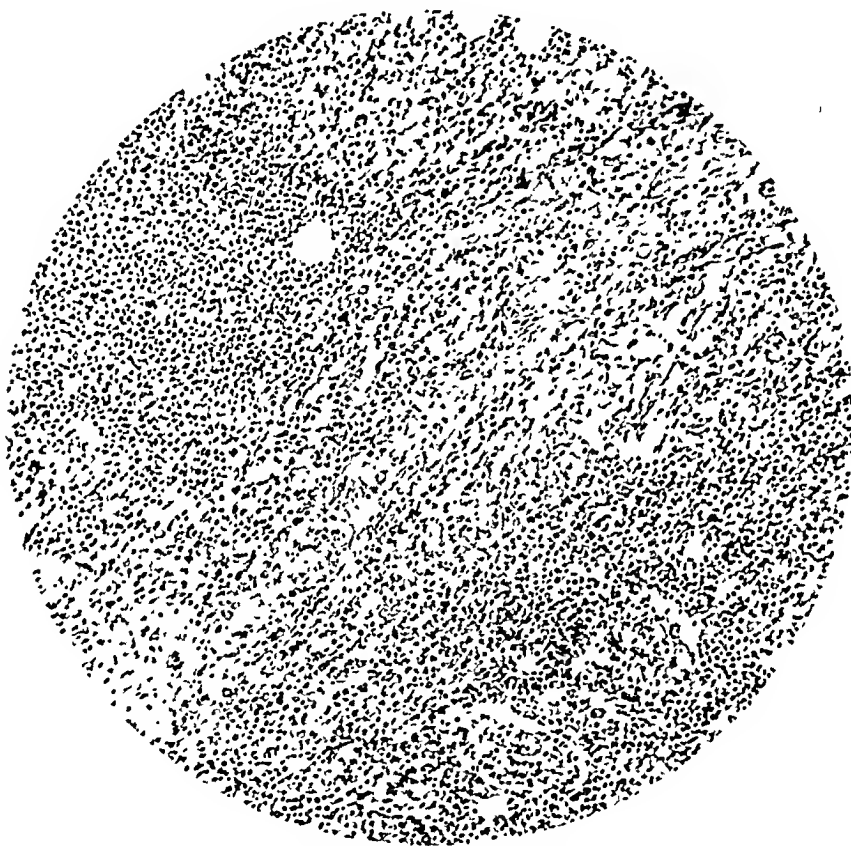


FIG. 1.—(CASE XII.) Section of breast showing numerous epithelioid tubercles.

admission she noticed a painful, tender swelling in the right breast. This became progressively worse, and the skin became inflamed. An incision was made two weeks later and some thin pus obtained. A second swelling appeared along the side of the incision and this too was incised, with the resultant discharge of a similar pus. The two nodules became larger, and a third one appeared on the outer side of the second incision. Examination revealed a patient in good health, and the heart and lungs normal. Roentgen ray examination of the chest showed no abnormality. Three swellings, varying in size from a marble to a walnut were found in the lower, outer quadrant of the right breast. The two larger ones, which had been incised, were still discharging thin pus. The nodules were tender and the skin over them was inflamed.

A diagnosis of tuberculosis of the breast was made. The smaller of the nodules was removed for study. *Pathologic report*: the small nodule is two cm. in diameter, and soft in consistency. The tissue is of a granulomatous nature, characterized by an

infiltration of many round and epithelioid cells; some giant cells are seen. A considerable amount of necrosis is present (Fig. 1). *Impression*: tuberculous mastitis. *Guinea-pig inoculation* was subsequently reported positive.

We advised conservative medical treatment in this case. The patient left the hospital December 1, 1933, at which time there was an oozing of thin pus from each of the incisions. The larger two nodules were still present and exquisitely tender.

Beginning December 7 patient reported at four-day intervals for medical treatment. At each visit she was given an ultraviolet irradiation up to the erythema dose. A Hanovia air cooled, mercury vapor, quartz lamp was used. Tuberculin ointment was rubbed into the skin for three minutes. Tuberculin (O. T.) is readily absorbed through the skin and may be conveniently applied in a fatty base (Rx. Tuberculin (O. T.), 0.40; adeps lanae hydrosus, 4.00; misce et fiat unguentum. Sig. Tuberculin Ointment, 10 per cent).

The skin of the outer aspect of the arm was cleaned with ether and alcohol. A quantity of ointment, the size of a split pea, was gently rubbed into the skin with a glass spatula for three minutes. In the course of 18 to 36 hours, an erythematous area appeared, which was rarely followed by papulation. Systemic effects did not appear. The application was repeated every fourth day. When the 10 per cent ointment failed to produce erythema, a 25 per cent ointment was used; finally a 50 per cent ointment was employed. At the end of two weeks the wounds became dry and the discharge had ceased. At the end of four weeks the nodules had practically disappeared and the patient had gained nine pounds. The necessity for continuing treatment for six months to one year was impressed upon the patient. She felt so well, however, that she thought further treatment was not essential. She continued in good health for the next eight weeks. She then received a blow on the right breast, which began to swell and appeared inflamed.

On May 7, 1934, a mass the size of an orange was palpable. It was exquisitely tender, and the skin over the mass was inflamed. The mass occupied the lower, outer quadrant of the breast. The axillary and cervical nodes were not enlarged. We advised her to resume medical treatment. However, because the pain was so severe, she insisted on immediate relief. She was admitted to the hospital and a simple mastectomy was performed. *Pathologic report*: the breast shows an advanced inflammatory process. Scattered throughout are numerous epithelioid tubercles, some containing giant cells. The presence of necrosis and a large number of polymorphonuclear leukocytes is indicative of a superimposed infection. *Impression*: tuberculous mastitis. *Bacteriologic study*: negative findings.

CONCLUSIONS

The response in Case XII to treatment by heliotherapy and tuberculin (O.T.) was gratifying. Whether the ultraviolet rays or the tuberculin (O.T.) played the predominating rôle in the result obtained, is conjectural. Unfortunately, because of the patient's refusal to continue further medical treatment, the case was terminated surgically. The result was sufficiently satisfactory, however, to warrant a trial of heliotherapy, or tuberculin (O.T.) therapy, or both, in similar cases.

Heretofore, all cases of tuberculous mastitis have been treated surgically. Coöperation of the surgeon and the internist will make possible the diagnosis sufficiently early, so that medical treatment can be instituted. Any form of medical treatment that offers the possibility of cure, without subjecting a young woman to the humiliation consequent to the loss of a breast, is deserving of a thorough trial.

TUBERCULOSIS OF THE BREAST

TABLE I
Analysis of Case Reports

Case	Sex	Age	Social Status	Child- dren	Method of Contrae- tion	Initial Symptoms	Trauma	Pain	Side	Quad- rant Involved	Size	Dura- tion	Nipple	Condition of Skin	Axillary Lymph Nodes	General Health	Bacteri- ology
1	F	37	M	2	Primary	Appearance of a lump in breast	No	No	Left	Lower inner	Hen's egg	8 wks.	Normal	Signs of inflam.	None	Good	—
2	F	44	M	—	Primary	Swelling of breast	Yes	No	Right	Lower outer	Small orange plum	10 wks.	Normal	No inflam.	None	Good	Negative
3	F	47	M	—	Primary	Appearance of nodule in breast	No	Late	Right	Lower inner and outer	Plum	6 mos.	Normal	Signs of inflam.	None	Good	—
4	F	26	M	2	Primary	Pain and swelling of breast	No	Early	Left	Lower outer	Marble	3 mos.	Normal	Signs of inflam.	None	Good	—
5	F	33	M	—	Primary	Pain and swelling of breast	No	Early	Right	Lower inner	Walnut	4 mos.	Normal	Signs of inflam.	None	Good	Numerous acid-fast bacilli
6	F	42	M	—	Primary	Appearance of mass in breast	No	No	Right	Lower inner	Plum	2 wks.	Normal	No inflam.	None	Good	—
7	F	37	M	3	Secondary	Appearance of nodules in breast	No	No	Left	Lower outer	Marble	4 wks.	Retracted discharge	No inflam.	Present	Rales in chest	—
8	F	44	M	7	Primary	Discharge from nipple	No	Late	Left	Under nipple	Hen's egg	3 wks.	Retracted discharge	Signs of inflam.	Present	Good	—
9	F	36	M	3	Doubtful	Swelling of breast	No	Late	Left	Lower outer	Hen's egg	19 mos.	Retracted	No inflam.	Present	Good	—
10	F	36	M	3	Primary	Pain and nodule in breast	No	Early	Right	Upper outer	Marble	—	Normal	No inflam.	Present	Loss of weight	Negative
11	F	53	M	7	Primary	Nodule in breast	No	Late	Right	Upper inner	Marble	7 wks.	Normal	No inflam.	Present	Good	—
12	F	26	M	2	Primary	Pain and nodule in breast	Yes	Early	Right	Lower outer	Walnut	7 mos.	Normal	Inflam.	None	Good	Positive

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ACUTE CHOLECYSTITIS ASSOCIATED WITH PANCREATIC REFLUX

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IN 1901, Opie¹⁴ reported a case of acute hemorrhagic pancreatitis in which autopsy disclosed a calculus, occluding the duodenal orifice of the ampulla of Vater, but so small that the orifices of the choledochus and pancreatic duct were unobstructed. The two ducts, therefore, were converted into a continuous channel. This made possible the retrojection of bile into the pancreatic duct which probably accounted for the acute pancreatitis present. Stimulated by Opie's observation, other instances of acute pancreatitis were reported in which the pancreatic tissues were bile stained.

Interest was then aroused as to the different anatomic arrangements of the ducts in relation to the ampulla of Vater, and in which type of variation the lodgment of a small stone would convert both ducts into one continuous channel. Investigators have reported varying results. Mann and Giordano¹² concluded that in 3.5 per cent of their dissections the termination of the ducts was such that a continuous channel could be effected if the papilla were obstructed. From roentgenologic studies of ducts injected with lipiodol, Schmieden and Sebening¹⁷ found that this anatomic arrangement was present in 20 per cent of their cases. Subsequently, by occluding the papilla with a small stone and pouring Woods metal into the choledochus, Cameron and Noble⁶ noted that the pancreatic duct was in the mold of 75 per cent of the preparations. If the biliary reflux is to be considered in the etiology of acute pancreatitis, there must be other factors causing papillary obstruction inasmuch as the incidence of a stone occluding the ampulla is small.

In a collected series of 1,278 cases of acute pancreatitis, Schmieden and Sebening found that the ampulla was obstructed by a calculus in only 4.4 per cent, and in a series of 51 cases of primary acute pancreatitis reported by one of us⁸ in 1930, a papillary calculus was found in only one instance, although the common duct was definitely dilated in seven. The statement was made then that "the ampulla of Vater may be occluded either reflexly, or by the edema and spasm incident to the passage of stone in some cases, and in others by an inflammatory pancreatic enlargement."

Undoubtedly, edema of the papilla and spasm of the sphincter of Oddi not infrequently convert the choledochus and duct of Wirsung into one channel. Balo and Ballon² reported the necropsy findings in four cases of simple catarrhal jaundice without stone in which a retention of pancreatic juice and simultaneous jaundice was presumably due to swelling and edema of the

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duodenum and papilla. The rôle of spasm of the sphincter of Oddi was stressed and verified by Archibald¹ in his work on this sphincter in cats. This was subsequently corroborated by Westphal¹⁸ who made a detailed study of the actions of the muscles near the orifices of the choledochus and the large pancreatic duct, and emphasized the functional importance of this muscular area in normal and pathologic processes. In addition, he demonstrated in 42 of 50 cadavers that the anatomic relationships were such that the flow within the bile and pancreatic ducts could occur in either direction.

However, there is even more conclusive clinical evidence proving that spasm or edema under certain anatomic conditions may convert the orifices of the choledochus and the duct of Wirsung into a cloaca, resulting in the appearance of pancreatic ferments in the bile. This is well recognized by the occasional occurrence of severe skin digestion about biliary fistulae. Chemical analysis of the biliary discharge in these cases invariably discloses the presence of pancreatic ferments in large amounts. These ferments can only be accounted for by pancreatic reflux in the absence of duodenal contents either from a fistula or retrojection. Nordmann¹³ recorded two cases of acute pancreatitis in which pancreatic ferments were present in the drainage from a choledochostomy, and Westphal,¹⁸ too, demonstrated large quantities of ferments in a dilated choledochus.

But pancreatic ferments are not as infrequent in the biliary system as these few isolated instances would seem to indicate. In a recent communication, Popper¹⁵ stated that he examined the bile (usually from the gallbladder) in 219 surgical cases for the purpose of finding pancreatic ferments. The samples examined represented cases of cholelithiasis, tumors of the pancreas, acute pancreatic disease, and cases with a healthy biliary system. Diastase was routinely sought for as a proof of the presence of pancreatic juice. Ferments were demonstrable in 17 per cent of the cases, and if those of acute pancreatic disease were excluded, 20 of 200 bile samples contained diastase. The cases in which the bile ducts contained pancreatic juice differed in no way from other cases of cholelithiasis in respect to case history, symptomatology, clinical course, operative condition, or postoperative course. Subsequent follow up examinations, months or years later, showed no indication whatsoever of any pancreatic or hepatic dysfunction. Evidently the reflux of pancreatic ferments into the bile passages is of pathologic significance only when there is prolonged blockage of the ampulla in association with other conditions.

Once a common channel has been established, the direction of flow is undoubtedly dependent upon the relative secretory pressures of the bile and pancreatic juice. Investigators are not in accord, however, as to these pressures, but the weight of evidence seems to favor the pressure as being higher in the pancreatic duct.¹¹ Hence the increased likelihood of ferments being found in the bile, rather than bile in the pancreatic duct. However, intra-ductal pancreatic pressure may be lower if the accessory duct of Santorini is present. When this communicates with the duct of Wirsung, it might

easily act as a safety valve and diminish the pressure in the main duct sufficiently to permit bile to flow into the pancreas. When this occurs, an acute pancreatitis may follow. If, however, the flow is in the opposite direction, and pancreatic juice enters the choledochus, an acute cholecystitis, or more rarely a nonperforative bile peritonitis may ensue.

Cases of nonperforative bile peritonitis bear an interesting relationship to pancreatic reflux. In 1910, Clairmont and Haberer⁷ reported a case of bile peritonitis without perforation of the bile passages. They suggested that this might have been caused by alteration of the permeability of the bile duct walls, but offered no explanation for its occurrence.

Blad³ later endeavored to explain these unusual cases from a correlation of chemical and animal experiments. He felt that the pancreatic ferments refluxly present in the biliary system in association with bacterial action digested the colloids of the bile and liberated the pigment which by some unknown process could pass through any membrane.

By injection of human pancreatic juice into the choledochus of animals, Westphal¹⁸ was able to produce acute and chronic pathologic changes in the liver, gallbladder and extrahepatic bile ducts, many of which were comparable to those found in the human. He felt that the action of trypsin must be considered an uncommon, but nevertheless an important factor in the production of cholecystitis, in addition to infection, lithiasis, stenosis, or motor dysfunction of the biliary passages.

Wolfer¹⁹ subsequently verified Blad's observations and some of Westphal's by a series of ingenious experiments based upon the entrance of pancreatic juice into the gallbladder. He concluded that these ferments so devitalized the gallbladder wall that bacterial invasion, especially of anaerobes, was favored. He also felt that the alkalinity of the pancreatic juice transferred the ordinarily acid medium of the gallbladder bile into an alkaline one, and that this might account for the violent reaction in the mucosa of the gallbladder.

The exact mechanism of the chemical inflammatory reaction occurring in cases of acute cholecystitis in which pancreatic ferments have been found in the gallbladder bile is doubtful. It is evident from a review of the literature, especially the work of Popper,¹⁵ that pancreatic ferments may be present within the biliary tract and cause no damage. However, under certain conditions, the mixture of bile and pancreatic juice otherwise apparently innocuous, may be converted into a destructive tissue irritant, resulting in an alteration of the permeability, and in a chemical inflammation of the gallbladder wall. Dragstedt, Haymond, and Ellis⁹ have recently thoroughly reviewed the pathogenesis of acute pancreatitis. They called attention to many facts which might explain the production of acute cholecystitis by the presence of pancreatic ferments in the bile. Nonactivated pancreatic juice as it exists in the duct system of the pancreas is nontoxic, either on intravenous or intraperitoneal injection, and even activated trypsin is not able to destroy healthy living tissue. Bile apparently produces its local toxic and cytolytic effects

through the bile salts, which have been shown to constitute the toxic element in bile. Gallbladder bile, because of its greater concentration of bile salts, should be and undoubtedly is more effective in its destructive activity than hepatic duct bile. There is, however, an important element which tends to neutralize the destructive effect of an increased concentration of bile salts in the gallbladder. Bile as it is secreted by the liver is invariably alkaline, whereas under normal conditions the bile in the gallbladder tends to be kept acid through the selective concentrating activity of that organ. Bile salts are far more soluble, and, therefore, much more toxic under alkaline than under acid conditions. If a large quantity of pancreatic juice is retrojected into the gallbladder, the alkalization of the normally acid gallbladder bile, together with the presence of pancreatic ferments probably activated by infected bile, produce conditions favorable for tissue destruction. Trypsin, now activated, may act in several ways. It may digest the proteins which have a definite protective action against the destructive effects of the bile salts. It may remove the taurine and glycine from the conjugated bile salts, liberating the more toxic free bile acids. Finally, it may be regarded as an active catalyst and, as such, accelerate a reaction which otherwise would take place slowly, thereby increasing and enhancing the toxic effect of the bile.

Active pancreatic ferments have been found in the bile of acutely inflamed gallbladders, and their presence appears definitely related to the acute inflammatory process present. Such instances have been reported by Bundschuh,⁵ Ruppanner,¹⁶ Dziembowski,¹⁰ and Brackertz.⁴ Three similar cases of acute cholecystitis associated with the presence of pancreatic enzymes in the gallbladder bile have been observed on the Surgical Services of the Mount Sinai Hospital during the past year.

CASE REPORTS

CASE I.—History No. 357862, M. McG., a well-developed and stout Irish laborer of 65, was admitted to the Surgical Service of Dr. Harold Neuhof on October 7, 1933, for acute urinary retention due to prostatism. On October 13, 1933, a suprapubic cystostomy was performed. Two days later, without ever having had any previous symptoms of a similar nature, while lying in bed, he developed sudden acute persistent pain in the right upper quadrant. On examination, the gallbladder was found to be palpable, markedly tender and distended. Temperature 103°. The symptoms disappeared within two days. Ten weeks later, while convalescing from a second-stage prostatectomy, the same symptoms suddenly recurred and after three days of conservative treatment, it was felt that operation was indicated. On opening the peritoneal cavity, the gallbladder was found to be distended. The wall was thickened, edematous and gangrenous in several areas, and covered with recent omental adhesions. It contained 60 cc. of thick dark bile and several small cholesterol stones in the cystic duct. Free, bile-stained fluid was found in the peritoneal cavity, although no visible perforation was apparent in the gallbladder wall. After its removal, the gallbladder was distended with formalin and no perforation was found. The liver was normal in appearance. Convalescence was uneventful. On analysis the gallbladder bile was found to be markedly alkaline with a pH of 7.75 (normal 6.8 to 7.1). By qualitative tests, large amounts of both amylase and trypsin were found to be present. Cultures of both the bile and gallbladder wall were found to be sterile.

Microscopic Findings.—Sections were taken from the fundus, neck and ampulla of

the gallbladder. These showed essentially identical changes. The mucosa and lamina propria were necrotic. There was a marked polymorphonuclear leukocytic infiltration immediately below the epithelium which extended down through the muscular and fibrous coats and subserous tissues to the serosal wall (Fig. 1). The entire wall was edematous and a pronounced fibrinous exudation was present. The vessels were dilated and engorged, and frequently surrounded by polymorphonuclear leukocytes, which, at times, extended into the wall of the vessels. The lymphatics were likewise dilated and filled with nuclear debris. No fat necrosis was observed microscopically. The entire gallbladder was then stained with Benda's solution and carefully sectioned for evidences of fat necrosis. None were found. Bacteria were not found in the microscopic sections.

CASE II.—History No. 36343I, R. M., a well-developed, rather thin 25-year-old Porto Rican woman, was admitted to the Surgical Service of Dr. Harold Neuhoof on March 7,



FIG. 1.—(CASE I.) Photomicrograph of gallbladder wall showing acute diffuse inflammation. Diffuse polymorphonuclear leukocytic infiltration of wall with marked edema (hematoxylin and eosin).

1934. For the past 18 months she had suffered from six acute attacks of sharp pain in the right upper quadrant, radiating to the epigastrium and occasionally to the back. The pain was accompanied by nausea, vomiting and slight jaundice. Each attack persisted about two weeks during which time there would be only intermittent amelioration of the symptoms. In the intervals between attacks, belching and distention were marked; fatty foods could not be tolerated. The last attack, which began two days before admission, was the most severe and persisted up to the time of operation. On admission, unusually acute tenderness was noted in the right upper quadrant. Temperature 101°. At operation, five days after the onset of the last attack, the liver was found enlarged, extending about five cm. below the costal margin. It was deep red and congested. The gallbladder was closely surrounded by edematous omentum containing several areas of fat necrosis. Upon careful separation of the omentum from the gallbladder, a thin layer of definitely bile-tinged fluid was found. The gallbladder itself was enormously distended. The edematous thickened walls showed many areas of gangrene and fat necrosis. One hundred cm. of blackish bile were aspirated and several buckshot-sized cholesterol

stones were found in the cystic duct. Because of the acute inflammatory process, cholecystectomy was performed without further exploration. The patient was discharged on the 13th day, after a smooth convalescence.

The gallbladder bile was found to be alkaline with a pH of 7.78 and contained 450 Elman units of amylase per cc. Trypsin could not be detected. Cultures of both the gallbladder wall and the bile were found to be sterile.

Microscopic Findings.—Numerous sections from various areas of the gallbladder revealed identical changes. There was a marked necrosis of the mucosa extending into the subepithelial tissues, and in many places into the muscularis and subserous tissues. A diffuse polymorphonuclear leukocytic infiltration was present throughout. These cells were often collected in masses about necrotic foci. The vessels were dilated, the walls often infiltrated by leukocytes, and the lymphatics were filled with pyknotic debris.



FIG. 2.—(CASE II.) Photomicrograph of gallbladder wall showing large subserous area of fat necrosis. Calcium deposit surrounds necrotic fat cells. Entire area surrounded by a wide zone of inflammation (hematoxylin and eosin).

The entire subserosa, in many sections, contained extensive areas of fat necrosis (Fig. 2), the necrotic fat cells taking a deep blue color with the hematoxylin and eosin stain. The necroses frequently involved the serosa, although microscopically it was not possible to determine whether actual perforation had occurred. The entire gallbladder was stained with Benda's solution. This revealed many scattered subserosal areas of fat necrosis (staining a deep green color) chiefly present on the free surface of the gallbladder. Bacteria were not found in the microscopic sections.

CASE III.—History No. 371810, A. L., a well-nourished Italian woman of 41, was admitted to the Surgical Service of Dr. Ralph Colp on October 6, 1934. The patient had been perfectly well up to 15 hours before admission when she suddenly developed epigastric pain which spread to the periumbilical region and to the right lower quadrant. After two hours, the pain suddenly became very severe and was accompanied by chilly sensations and vomiting. On admission, the patient appeared to be acutely ill and in

great pain. Tenderness and rigidity were marked on the right side of the abdomen; the right upper quadrant being excruciatingly tender. Temperature 101.4°.

Nineteen hours after the onset of symptoms operation was performed. Grayish pus was found free in the upper abdomen and over the superior surface of the liver. The gallbladder was greatly distended, acutely inflamed, and the wall thickened and edematous. One small point of gangrene was noted but the gallbladder was found subsequently not to be perforated. Cholecystectomy was performed. Fever persisted for two weeks rising to 102° at times. On the ninth day postoperatively, bile began to flow through the site of drainage. This persisted until the 20th day when five very small mulberry-shaped cholesterol stones were discharged through the sinus, following which the sinus closed rapidly. The patient was discharged on the 35th day, symptom free.

The gallbladder bile was found to be very alkaline, the pH being 8.85. Both



FIG. 3.—(CASE III.) Photomicrograph of gallbladder wall showing focal necrosis of mucosa and diffuse submucosal infiltration of polymorphonuclear leukocytes with marked edema. A dilated lymphatic vessel is filled by leukocytic exudate (hematoxylin and eosin).

trypsin and amylase were present in large quantities; the amylase being 200 Elman units per cc. The blood amylase taken at the time of operation was 2.6 units. Culture of the gallbladder wall and gallbladder bile showed the presence of both *Bacillus Friedländer* and *Bacillus coli*. Culture of the peritoneal pus was sterile.

Microscopic Findings.—There was a widespread necrosis of the mucosa of the gallbladder. The necrotic areas were surrounded by dense infiltrations of polymorphonuclear leukocytes. The entire wall showed a most striking edema, together with a diffuse polymorphonuclear leukocytic infiltration, which extended to the serosal wall (Fig. 3). The latter was covered in areas by fibrinous exudate. In addition to the edema, there was an exudation of fibrin which was present in the form of wide bands, chiefly in the subserous and fibromuscular layers. The lymphatic and blood vessels were dilated and engorged. The entire gallbladder was stained with Benda's solution but no areas of fat necrosis were found upon careful sectioning. No bacteria were found in the microscopic sections.

The history and physical findings in these three cases are typical of acute gallbladder disease. While the inflamed gallbladders, presented the characteristic pathologic changes noted in the various stages of acute cholecystitis without perforation, there were other features present which were unique or unusual and not found in a control series of 70 cases of acute and chronic gallbladder disease.

In Cases I and II, free bile was present in the peritoneal cavity, and in Case II, fat necrosis was seen not only throughout the gallbladder wall, but also in the omentum adherent to the inflamed gallbladder. The cultures were sterile in the first two cases, and *Bacillus coli* and *Bacillus Friedländer* were present in the third. No bacteria were found in the microscopic sections of the gallbladder in any of the three cases.

The gallbladder bile was definitely alkaline in all cases. Diastase was present in large amounts in the bile aspirated from the gallbladder at the time of operation. The amounts of pancreatic ferments present could only be accounted for by pancreatic reflux. Retrojection of duodenal juice charged with pancreatic ferments into the bile ducts can be excluded together with the assumption that pancreatic ferments entered the bile by way of excretion by the gallbladder mucosa, or through the blood or lymph streams.

Pancreatic reflux as an initiating or precipitating cause of acute cholecystitis is probably more common than the paucity of cases reported would seem to indicate. If pancreatic ferments are found as frequently as Popper reports, their rôle, under certain conditions, not only in acute cholecystitis but also as a possible causative agent in the production of chronic gallbladder disease as Westphal has shown experimentally, cannot be denied.

Methods.—In the first case presented, the determination of both amylase and trypsin was done by qualitative methods, made roughly quantitative by using varying dilutions. Thus the amylase determination was estimated by the disappearance of the blue color produced by iodine in a 1 per cent starch solution incubated with varying dilutions of the bile. It was noted that a fourfold dilution produced splitting of the starch. Similarly a Mett tube showed digestion of the albumen in this sample diluted six times, evidence of a fairly high concentration of trypsin.

In Cases II and III, the amylase was determined quantitatively by means of the viscosimeter method of Elman, in which the equivalent of one unit of amylase, acting for one hour on five cc. of a 3 per cent starch solution, reduced the viscosity by 20 per cent. The starch solution was standardized so that various samples of normal human serum gave an amylase content of two to five units.

Amylase determinations of bile obtained from other cases of both acute and chronic cholecystitis were attempted. In such cases only unmeasurable traces of amylase could be detected. The presence of trypsin was assayed by incubating the bile with Mett tubes. The pH was determined in all cases potentiometrically by means of the hydrogen electrode.

CONCLUSIONS

It has been shown that if certain anatomic relationships exist between the choledochus, duct of Wirsung and the papilla of Vater, both ducts may be converted into a single continuous channel by obstruction of the papilla. This papillary obstruction might be caused either by a calculus, or by edema of the duodenum and papilla, or by spasm of the sphincter of Oddi muscle.

Once a single channel has been established, bile may flow into the duct of Wirsung or pancreatic juice may flow into the choledochus. The varying intraductal pressure is probably the factor which determines the direction of the flow.

If pancreatic juice refluxly enters in the biliary system, no clinically recognized sequelae may result. On the other hand, if the pancreatic ferments are present in the gallbladder bile in sufficient concentration and amounts to change its usual acid reaction to alkaline, the bile salts may act destructively on the gallbladder wall together with the activated pancreatic ferments. As a result of the chemical inflammation caused by these various factors, either an acute cholecystitis or nonperforative biliary peritonitis may result.

Three cases of acute cholecystitis associated with the presence of pancreatic ferments in the gallbladder bile are reported.

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SURGERY OF THE GALLBLADDER AND BILIARY TRACT

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A THOROUGH study has been made of 360 consecutive cases of non-malignant diseases of the gallbladder and biliary tract treated at the New York Hospital from September 1, 1932, to January 1, 1935. There is presented for consideration in this review: (1) A brief discussion of the problems which were presented. (2) A detailed description of the method employed in exploring and draining the common duct. (3) An outline of the policy of the treatment of acute cholecystitis. (4) A summary of the hazards encountered in biliary tract surgery, as evidenced by an analysis of the deaths in this series of cases.

(1) STATISTICAL RÉSUMÉ.—Certain clinical facts were noted from the study of the histories of this group of patients. Gallbladder and biliary tract diseases occur more frequently in women than in men, a ratio of 4 to 1. Eighty per cent of the women afflicted associated the onset of symptoms with their first pregnancy. The age of the patients ranged from 8 to 81 years; the largest number, however, were between 40 and 50 years of age. The duration of symptoms varied from a very short time, as in an initial attack, to 40 years; the average duration was five years. The classic symptoms of gallbladder disease occurred in the following order of frequency: (a) belching, (b) attacks of colicky pain, (c) intolerance of fatty foods, (d) attacks of nausea, (e) attacks of vomiting and (f) jaundice.

An exhaustive physical examination was made in every case. Abnormal findings were investigated further by special methods; the cardiovascular and renal systems were carefully checked; renal function and blood urea determinations were made to confirm the clinical findings. If these examinations revealed impaired function of any system, an effort was made to repair the damage before operation in order to avoid postoperative complications. Upper respiratory infections were treated by rest in bed and local therapy unless the surgical condition demanded immediate operation. The dental therapist was called upon to correct infection in the mouth, which is a contributing factor in some of the postoperative pulmonary complications. Post-operative distention was forestalled by thorough evacuation of the gastrointestinal tract. It was evident in these cases that a favorable fluid balance and a good glycogen reserve protected the patient during anesthesia and operation. Roentgenography was not employed as a routine diagnostic measure; however, in the cases in which it was used the diagnosis was correct in 90 per cent.

The series of 360 cases of non-malignant diseases of the gallbladder and

biliary tract included 305 cases of acute, subacute or chronic cholecystitis treated by cholecystectomy with six deaths (1.9 per cent); 42 cases of common duct obstruction due to stone associated with acute or chronic cholecystitis treated by cholecystectomy plus choledochostomy or cholecystostomy plus choledochostomy with four deaths (9 per cent); eight cases of acute or subacute cholecystitis treated by cholecystostomy with no deaths; and five cases of common duct obstruction following previous operation, treated by plastic operations on the common duct, two deaths; mortality 40 per cent.

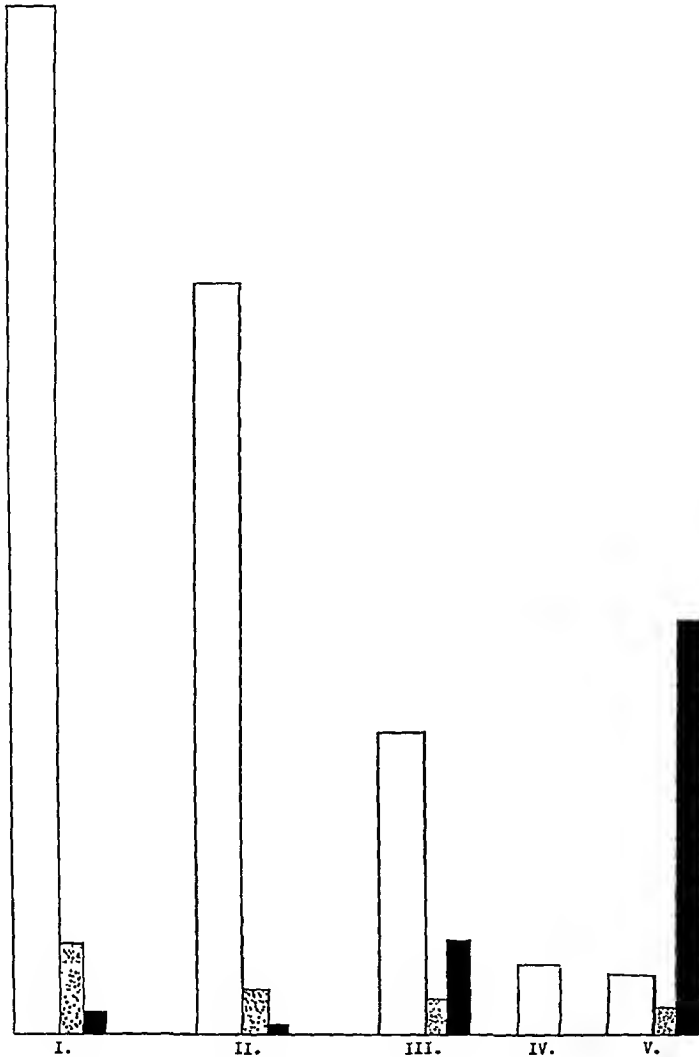


CHART I.—Non-malignant diseases of the gallbladder and biliary tract. (I)—Total 305 cases, 6 deaths, mortality 1.9 per cent. (II)—42 cases treated by cholecystectomy plus choledochostomy or cholecystostomy plus choledochostomy, 4 deaths; mortality 9 per cent. (III)—Eight cases treated by cholecystostomy, no deaths. (IV)—Five cases of common duct obstruction following previous operation, treated by plastic operations on the common duct, 2 deaths; mortality 40 per cent.

cases of common duct obstruction following previous cholecystectomy with long-standing jaundice, treated by plastic operations upon the common duct with two deaths (40 per cent). The total mortality for the 360 cases was 3.3 per cent (Chart I).

(2) INDICATIONS AND METHODS FOR EXPLORATION OF THE COMMON DUCT.—Lahey¹ states that "the ducts should be opened and searched for stones whenever the gallbladder is found thickened or contracted." We do not believe that the common duct should be explored routinely because it is a formidable procedure, adding definitely to the postoperative burden and sometimes to the mortality rate. We feel that exploration of the common duct should be reserved for cases (a) in which there are stones palpable in the duct; (b) in which there has been a history of progressive jaundice or repeated attacks of jaundice; (c) in which the common duct is dilated and (d) in which the head of the pancreas is indurated. Induration of the head of the pancreas is often associated with obstruction due to stones in the ampulla of Vater and should be considered an indication for, rather than against, exploration. The indurated common duct found in acute and sub-acute inflammatory processes of the gallbladder and which is associated with only a mild degree of jaundice (icteric index of 30 or less) should not be molested, for it seldom contains stones. If the duct is distended, as well as indurated, the situation is altered. Patients with cholecystitis and cholelithiasis, giving histories of repeated attacks of jaundice, should be explored with particular care not to overlook stones; it is in these cases that exploration has revealed stones in the hepatic ducts. In reviewing the autopsy findings in the 12 deaths, we found two instances in which stones in the common duct had been overlooked at operation. Unfortunately, this is not an uncommon experience in surgery of the common duct and any method which tends to eliminate it should be employed. We have found the Cameron light of distinct value in meeting this problem. The procedure is as follows: An incision is made in the common duct just below the entrance of the cystic duct, sufficiently large to admit such instruments as may have to be introduced (2 to 3 cm.). One traction suture of silk is placed on each side of the opening in the wall of the common duct to facilitate visual inspection of its lumen. When the thickness of the wall, and the degree of induration and distention have been estimated, a small Cameron light is introduced and passed downwards toward the duodenum. If there is an obstruction, its position can be determined and because of the difference in density of stones and the duct, the stones will be clearly outlined, enabling one to determine the nature of their surface. With the light in the duct, an attempt can be made by manipulation to express the stone upwards. If this does not meet with success, it may be possible to remove the stone with a forceps or probe. Some soft stones break into pieces and can be removed piecemeal. This procedure, however, is dangerous because it may injure the wall of the duct, and inadvisable because of the possibility of failing to remove all the fragments. A catheter introduced into the common duct will frequently relieve the obstruction by dislodging the stone (Figs. 1 and 2).

When the obstruction has been relieved, the light is passed down to the ampulla of Vater; if there are stones in this region, they will be outlined against the less dense walls. This is an especially important procedure, be-

cause it is here that stones are most easily overlooked as it is possible to introduce a catheter past them into the duodenum and to irrigate around them without noting an obstruction.

The light is now removed and a catheter inserted through the cystic duct into the common duct to a point below the orifice through which we have been working. The cystic duct may require dilatation with a curved clamp

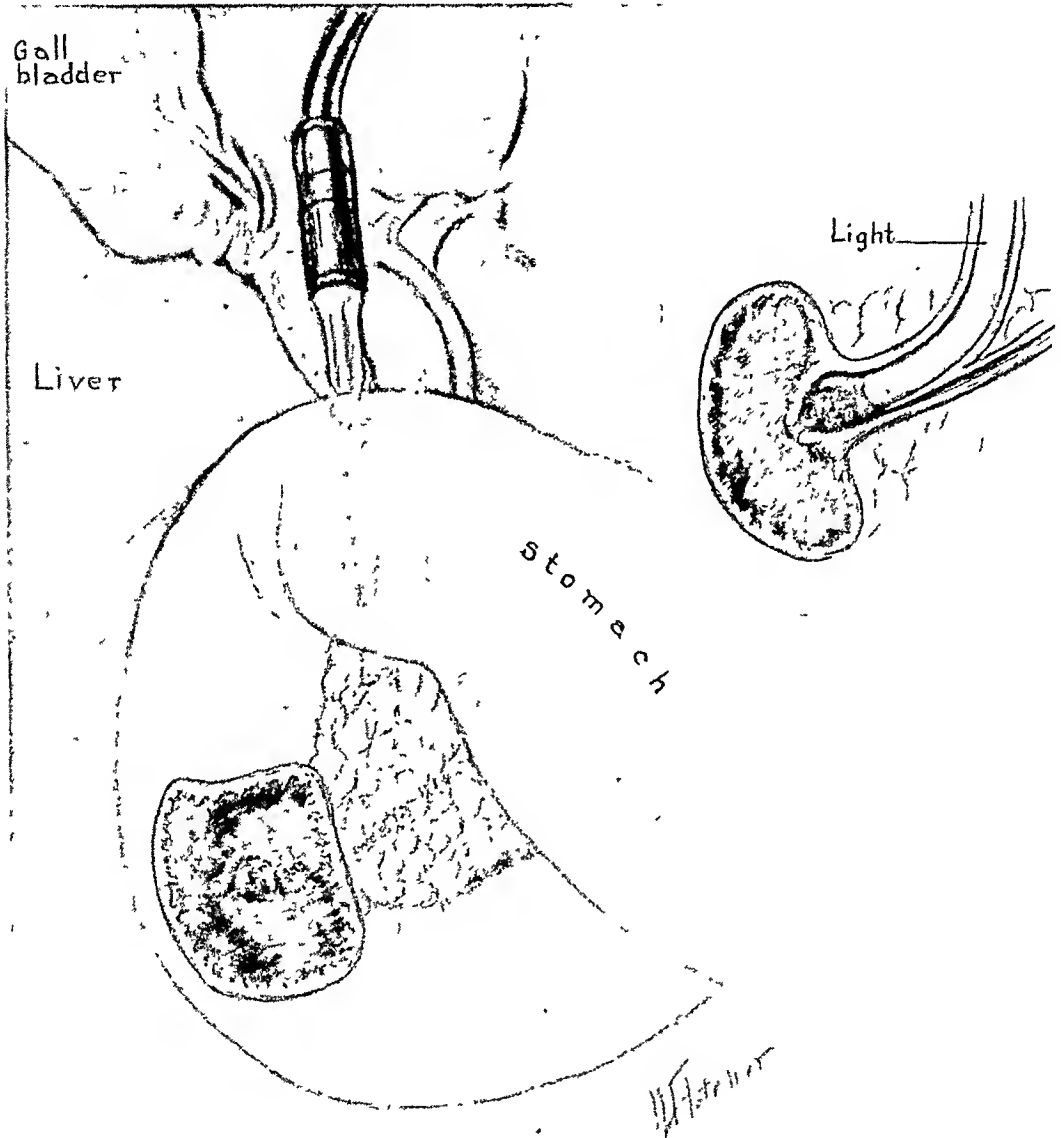


FIG. 1.—Exploration of the common duct facilitated by small electric light.

or a small dilator. The catheter should, however, fit the cystic duct snugly; its tip should lie above the ampulla of Vater. It is secured in this position by a ligature of plain catgut. The procedure terminates with the closure of the opening in the common duct (Fig. 2). This method of drainage of the common duct was described by Reid⁷ in 1920. Transection of the duodenum is obviously indicated when a large stone is impacted in the ampulla.

(3) ACUTE CHOLECYSTITIS.—There is a widely accepted opinion that the welfare of the patient with acute cholecystitis, on the whole, is best conserved by waiting for the acute process to subside and to then operate, if operation is contemplated, after the disappearance of the acute symptoms. The reasons set forth are based upon two premises: first, that the acutely inflamed viscus generally takes care of itself and that, therefore, complications due to gangrene and perforation do not occur; and second, that there is greater danger to the patient to undergo an operation during the acute stage of the inflam-

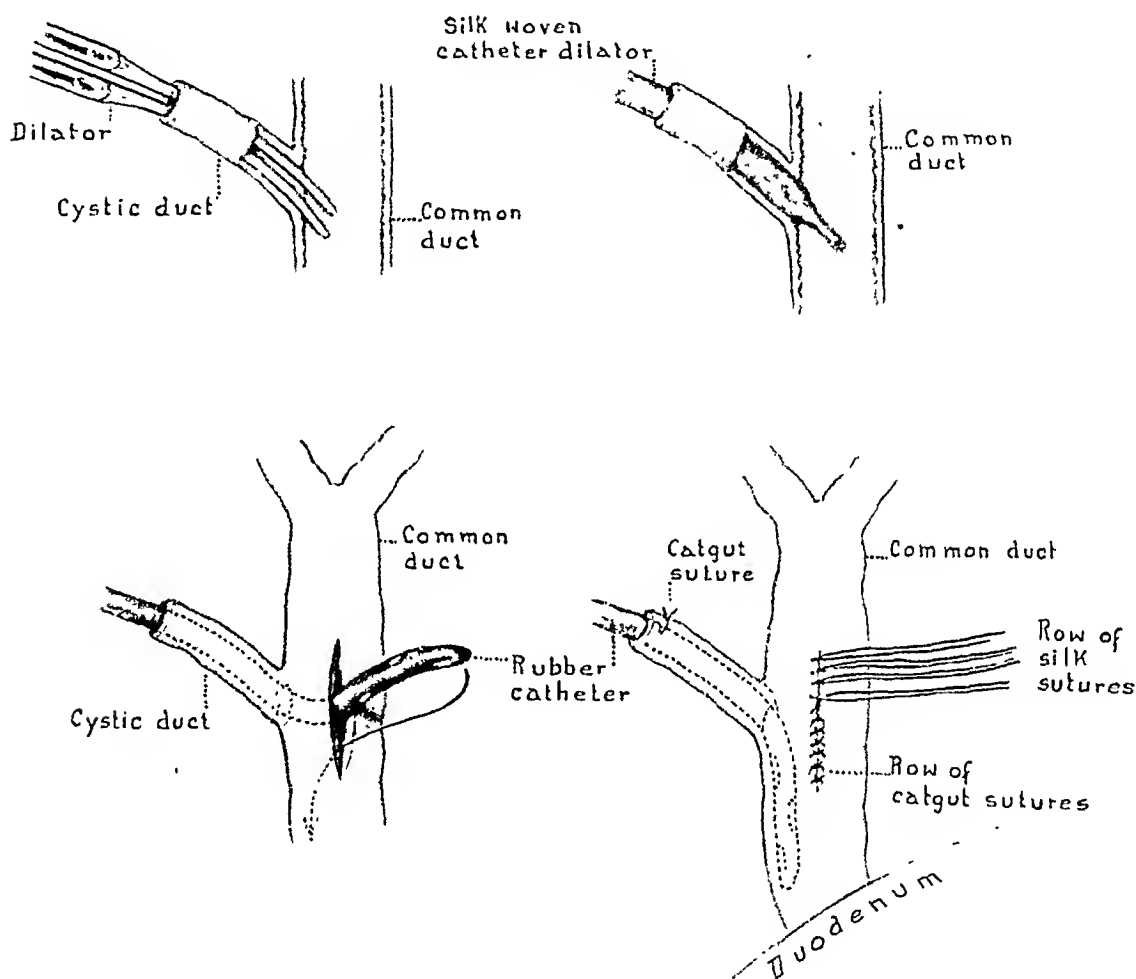


FIG. 2.—Drainage of the common duct through the cystic duct.

matory process than during an interval or chronic stage. As to the first supposition, it may be said that the majority of cases of acute cholecystitis do subside; however, those that do not contribute in large measure to the high mortality in the surgical treatment of this disease. The second assumption, that there is increased danger to the patient from an operation during the acute stage of the disease, is not borne out in our experience. In 80 cases of acute cholecystitis treated in the early stages, there were four deaths (5 per cent). It will be seen that this mortality is no higher than the mortality rate for cholecystectomy in chronic cholecystitis and cholelithiasis. A study of the literature shows that these figures compare well with those of

many other clinics. We believe that most surgeons will agree with the statement that the acutely inflamed gallbladder may be removed more easily than the chronically inflamed viscus, and the postoperative course is no more stormy.

The danger of gangrene and perforation of the gallbladder in acute cholecystitis cannot too strongly be emphasized. In this series of acute cases, 80 in number, there were 12 instances of perforation (15 per cent). Heuer² in a review of the records of 800 patients with gallbladder and biliary tract disease treated in the old New York Hospital found that 21 per cent of the acute cases operated upon showed evidence of perforation. Zininger³ reports an incidence of 20.5 per cent; and Morris Smith⁴ 22.4 per cent. There are other observers whose statistics substantiate our estimate that between 15 and 20 per cent of all cases of acute cholecystitis show evidence of perforation. These are the cases which develop the associated conditions of abdominal abscess, liver abscess and peritonitis, which raise the mortality in gallbladder and biliary tract surgery.

(4) THE HAZARDS IN GALLBLADDER AND BILIARY TRACT SURGERY.—An analysis of the 12 deaths in this series of 360 cases shows that there are six factors which are chiefly responsible for the mortality. It is hoped that a study of these may lead to a better understanding of, and a safer approach to, cases of gallbladder and biliary tract disease. The causes of death will be discussed under the following headings: (1) Errors in technic and complications traceable to the operative procedure; (2) cardiorenal disturbances; (3) pulmonary complications; (4) jaundice; (5) acute cholecystitis and its immediate complications, gangrene and perforation of the gallbladder and (6) liver damage, insufficiency and liver death.

Errors in Technic and Complications Traceable to the Operative Procedure.—There were four cases in the series in which death may be said to have been due in part to errors in technic. In one case autopsy showed a local biliary peritonitis, in one a chronic subphrenic abscess and in two cases, postmortem examination revealed stones in the common duct which had been overlooked at operation. A method by which we may hope to avoid the latter occurrence has been described. The cause of death in the first cases can best be eliminated by slow meticulous performance of the operative procedure, with the least possible injury to the organs and tissues, with careful control of hemorrhage and the prevention of soiling of the peritoneum by adequate protection.

Cardiorenal Disturbances.—In a recent publication Heuer² emphasizes the importance of cardiorenal disturbances as a factor in the deaths in gallbladder and biliary tract surgery. He points out that 12 per cent of the mortality in a large series of cases taken from the literature could be accounted for by associated cardiorenal disease. In the small group of cases herein reported, cardiorenal disturbances seem to have led to a far higher percentage of fatalities, in fact 50 per cent of the deaths may be attributed to an impaired cardiorenal system. Marked arteriosclerosis alone seems to

add to the hazard of gallbladder surgery; seven patients were definitely arteriosclerotic. If arteriosclerosis is associated with definite hypertension, and six of the patients had a diastolic blood pressure of over 90, we have just reason for hesitancy in operating. Renal damage with albuminuria and increased blood urea nitrogen retention accompanying arteriosclerosis and hypertension becomes a very serious contra-indication to operation. The problem presented by patients of this type is not easy to solve, for there is an unexplained interaction between these disturbances and the disease which we are discussing. We know that the type of individual who is constitutionally prone to gallbladder disease is also subject to arterial hypertension, arteriosclerosis and myocarditis. In addition, chronic cholecystitis appears to predispose to cardiorenal disturbances. The combined efforts of physician and surgeon are required to deal with the preparation of such patients for operation. The most satisfactory results have been obtained with rest in bed, regulation of fluid intake and digitalization when indicated.

Pulmonary Complications.—Of the 12 patients who died following gallbladder surgery, seven were reported to have had pulmonary complications such as pneumonia, atelectasis and purulent bronchitis. We find it difficult to evaluate the importance of these findings. Patients with cardiorenal disturbances frequently die of a terminal pneumonia; but the pneumonia can be considered no more than a contributing factor in the death of these cases, for it is not always associated with the anesthesia nor with disease of the respiratory system. Frank postoperative pulmonary complications may be best avoided by the careful administration of inhalation anesthesia. Postoperative hyperventilation of the lungs by means of carbon dioxide and oxygen may be of value. The use of local or spinal anesthesia does not appear to materially reduce pulmonary complications.

Jaundice.—The observation that long-standing jaundice is associated with general debility and a tendency to hemorrhage was confirmed in this series of cases. Jaundice was present in seven of the patients who died; five of the seven had had biliary obstruction for a relatively long period of time; four died of hemorrhage.

The preoperative treatment of the patient with jaundice is far from satisfactory. An effort should be made to build up the patient's resistance to infection. This may be accomplished in part by intravenous administration of glucose and calcium salts with an adequate fluid intake. Small transfusions have been used with some benefit, but the hazard of operation in the presence of jaundice still remains high.

Acute Cholecystitis and Its Immediate Complications, Gangrene and Perforation of the Gallbladder.—One of the series of 12 deaths occurred in a patient with acute gangrenous cholecystitis complicating typhoid fever. Two cases of acute cholecystitis with histories of recurrent attacks associated with common duct obstruction died of localized peritonitis and abscess formation. In the experience of the surgeons who have contributed to the literature in the past decades, the complications of acute cholecystitis are largely pre-

ventable by operation in the early stages of the disease, before such complications have arisen.

Liver Damage, Insufficiency and Liver Death.—There was one death in the series which closely resembled what Dr. Heyd⁵ has termed "liver death." The patient had been jaundiced for a long time. Unfortunately, an autopsy was not obtained. Two patients gave evidence of impaired hepatic function before death, who prior to operation had satisfactory functional tests. Both cases, however, had cardiorenal disease and jaundice.

At the present time the causes of impaired hepatic function are not known. The iso-iodokan test devised by Graham⁶ is used to confirm our suspicion of impaired function. As a corrective measure, glucose is administered pre- and postoperatively; in addition, calcium salts are given but their value is not definitely known.

By reviewing the deaths which have occurred in this group of cases, we can appreciate the hazards incident to gallbladder and biliary tract surgery. Even with full recognition of the dangers involved, we must, however, at times operate upon patients who are not good surgical risks; seven of the 12 patients who died were observed over a period of three days before operation, and every method at our disposal was employed in an attempt to improve their condition preoperatively. Many of the successful cases were not good risks, but we cannot withhold surgical treatment even in cases in which operation is a serious hazard, if this is the only means of curing them of the disease.

SUMMARY AND CONCLUSIONS

(1) Three hundred and sixty cases of non-malignant diseases of the gallbladder and biliary tract are reported in which operation was followed by a mortality of 3.3 per cent. The mortality for cholecystectomy alone was 1.9 per cent; when combined with exploration and drainage of the common duct, cholecystectomy or cholecystostomy was attended by a mortality of 9 per cent. Secondary plastic operations, fortunately rarely necessary, led to a very high mortality (40 per cent).

(2) Exploration of the common duct should be carried out with great care in cases in which it is indicated. The use of a small Cameron light is advocated and the procedure is described.

(3) Acute cholecystitis should be treated in an early stage of the disease to escape the complications which contribute to the mortality.

(4) An analysis of the deaths in this series of cases shows that the chief causes of mortality in gallbladder and biliary tract surgery are an impaired cardiorenal system, jaundice and a damaged liver.

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APPENDICITIS

AN ANALYSIS OF 4,833 CASES

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OPERATIONS for acute appendicitis constitute the most frequent major surgical procedure in our hospitals today. The laity consider themselves better informed on the symptomatology and treatment of appendicitis than any other surgical condition. It is therefore startling to be informed through life insurance statistics that the mortality rate of appendicitis has markedly increased in the past 20 years, a period in which surgery has made so many advances. The degree of professional dissatisfaction may be indicated by the fact that in the past four years over 800 articles on appendicitis have been published in our medical journals. Miller¹ aptly terms the death rate "a menace to humanity, a disgrace to the medical profession and a challenge to us who claim to practice the science and art of surgery."

A survey of published statistics reveals a wide variation in mortality rates depending upon the methods of classification, the types of cases, and the variations in treatment. Mortality rates based upon vital statistics universally show an increase in the past 20 years. The Metropolitan Life Insurance Company² shows that the mortality rate for acute appendicitis rose from 10.6 per 100,000 for 1911 to 1914, inclusively, to 14.1 per 100,000 for 1927 to 1930, inclusively, and estimates that during recent years there have been approximately 25,000 to 30,000 deaths annually in the United States compared with 16,000 to 18,000 20 years ago. Adams,³ quoting the Registrar General's statistics, shows that the mortality rate in England has risen from 69 to 74 per 1,000,000 between 1913 and 1923. It is to be stressed that these statistics are based upon total deaths per unit population and not upon actual case reports, thus not indicating the incidence of this infection.

Walker² believes that in reality there exists an increased incidence, as well as an increase due to greater scientific knowledge and diagnostic skill. Statistics show a universal increased incidence of operations for appendicitis. Walker,² in 1934, compiled comparative statistics from literature for the two periods 1900 to 1915 and 1916 to 1932 and found that the general operative mortality in the latter period was about 2.5 per cent less than that of the first period. There are many published comparative mortality rate statistics^{2, 4} which show a decreased operative mortality in recent years. We may therefore rightfully conclude that while the mortality rate in appendicitis based upon vital statistics has been gradually rising, the mortality based upon operations for appendicitis has been gradually falling. Notwithstanding

this conclusion, however, acute appendicitis and its complications remains a challenge to the medical and surgical profession.

The analysis of the cases presented in this paper is based upon all cases of acute appendicitis that were operated upon, or that died without operation, on the various Surgical Services at the Methodist Episcopal Hospital, Brooklyn, from January 1, 1924, to January 1, 1934, inclusively. It does not include those cases which, while diagnosed as acute appendicitis, were not operated upon for various reasons and either recovered or having signed a release went elsewhere, and the ultimate outcome is unknown. It should be mentioned that a high majority of our cases are brought into the hospital by our ambulances which are maintained by the municipal government for the care of those unable to afford private physicians. Because of the physical and financial condition of these people, we receive a large percentage of poor operative risks and mismanaged or neglected cases. This can be fully appreciated only by those who have had similar experiences in treating these cases from the poorer sections of any large metropolitan city.

Table I is a complete analysis by years of all cases of appendicitis, divided into acute, chronic and prophylactic (those removed at the time of laparotomy for some other condition) and their mortality rates. During the ten year period 1924 to 1934, inclusive, there was a total of 4,791 operations for appendicitis with an operative mortality rate of 2.03 per cent. This included 2,260 cases of acute appendicitis with an operative mortality of 4.3 per cent; 1,368 cases of chronic appendicitis with a mortality of 0.58 per cent and 1,205 prophylactic appendectomies without a death attributable to

TABLE I
Summary of Cases with General Mortality by Years

Year	Total Appen- dectomies	Acute Appendicitis			Chronic Appendicitis			Prophy- lactic Appen- dectomies
		Total	Deaths	Mortality Rate %	Total	Deaths	Mortality Rate %	
1924.....	409	209	8	3.8	90	1	1.1	115
1925.....	361	166	4	2.4	100	0	0	95
1926.....	416	191	9	4.9	111	1	0.9	118
1927.....	435	202	12	5.9	128	1	0.8	106
1928.....	466	240	10	4.1	132	0	0	102
1929.....	551	252	12	4.8	167	0	0	138
1930.....	527	235	15	6.3	203	3	1.4	95
1931.....	596	266	11	4.1	113	0	0	220
1932.....	495	220	9	4.1	185	2	1.8	94
1933.....	535	279	12	4.3	139	0	0	122
Totals.....	4,791*	2,260	102	4.3 average	1,368	8	0.58 average	1,205

* Five died without operation. General mortality of both acute and chronic types 2.03 per cent.

this phase of the operation. It is apparent that in more recent years there has been a slightly increased incidence of acute cases, but the mortality rates of all types have shown only mathematical variation. The author has included under fatal cases all those cases which died during convalescence whether directly associated with the appendicitis or not.

Table II shows the incidence and mortality of the acute cases according to the pathologic diagnosis, 28 per cent of the cases being acute catarrhal or acute exacerbation of a chronic appendicitis with a mortality rate of 0.31 per cent, these two deaths being due to poliomyelitis—bulbar type, and pulmonary embolism, respectively. Thirty-nine per cent of the cases were acute suppurative or gangrenous without perforation or gross peritonitis with a mortality of 0.8 per cent. Of these seven deaths, four were due to lobar pneumonia, and one each due to gas gangrene of the abdominal wall, intestinal obstruction and general peritonitis. Eighteen per cent of the cases were acute suppurative or gangrenous, complicated by spreading peritonitis with a mortality rate of 4.8 per cent. In the correct diagnosis of the exact pathology in any case, there is a factor of variation. Our technical judgment demands minimal incision and manipulation, thereby lessening our opportunity to learn the extent of the peritoneal reaction. In reviewing these cases, the author was impressed by the many cases of acute suppurative and gangrenous appendicitis in which no rupture had occurred, the peritoneal fluid was only turbid and there was no macroscopic suppuration. The operator invariably diagnosed these as free from local or spreading peritonitis, yet, not infrequently, the cultures of this free fluid gave positive growths of intestinal flora and the pathologist reported multiple abscesses in the meso-appendix and serosa. Certainly a spreading peritonitis must have existed in many of these cases at the time of operation although it was not diagnosed and is not so classified here. Seven per cent of the acute cases showed definite localization and abscess formation with an operative mortality of 5.3 per cent. 9.2 per cent of the cases demonstrated diffuse generalized peritonitis with a mortality rate of 31 per cent. It is noteworthy that 23.1

TABLE II
Incidence and Mortality According to Pathologic Diagnosis

Type	Total	Incidence %	Deaths	Mortality Rate %
Acute catarrhal or acute exacerbation of chronic appendicitis.....	633	28	2	0.31
Acute suppurative or gangrenous appendicitis.....	872	38.6	7	0.80
Acute suppurative or gangrenous with spreading peritonitis.....	396	17.5	19	4.79
Acute suppurative or gangrenous with local abscess..	150	6.6	8	5.3
Acute suppurative or gangrenous with diffuse peri- tonitis.....	209	9.2	66	31

23.1 per cent perforated at time of operation.

per cent of our cases of acute appendicitis had ruptured by the time of operation. This is a higher incidence than nearly all other published statistics, Finley⁵ reporting 18 per cent in 3,913 cases. The incidence of the various pathologic types showed only slight yearly variation, the statistics for the last five years showing that, despite public education, our percentage of complicated cases was even slightly higher than in the first five years of this analysis.

These statistics compare favorably with those of Black⁶ who, in 1932, reviewed statistics as presented by 52 reporters in this country and abroad including 150 hospitals, 1,500 surgeons and 83,144 cases. There existed a wide variation, but the following are the average mortality rates according to the pathologic diagnosis:

Chronic.....	0.99 per cent
Acute.....	4.5 per cent
Suppurative.....	7.87 per cent
Gangrenous.....	8.73 per cent
Spreading peritonitis.....	21.19 per cent
Basic average.....	5.5 per cent

Sex.—An analysis of the incidence and mortality by sex revealed 48 per cent were males with 61 per cent of the deaths compared with 52 per cent of females with 39 per cent of deaths, showing almost equal incidence, but a greater mortality in the males. An analysis of the incidence by month and season showed a negligible variation.

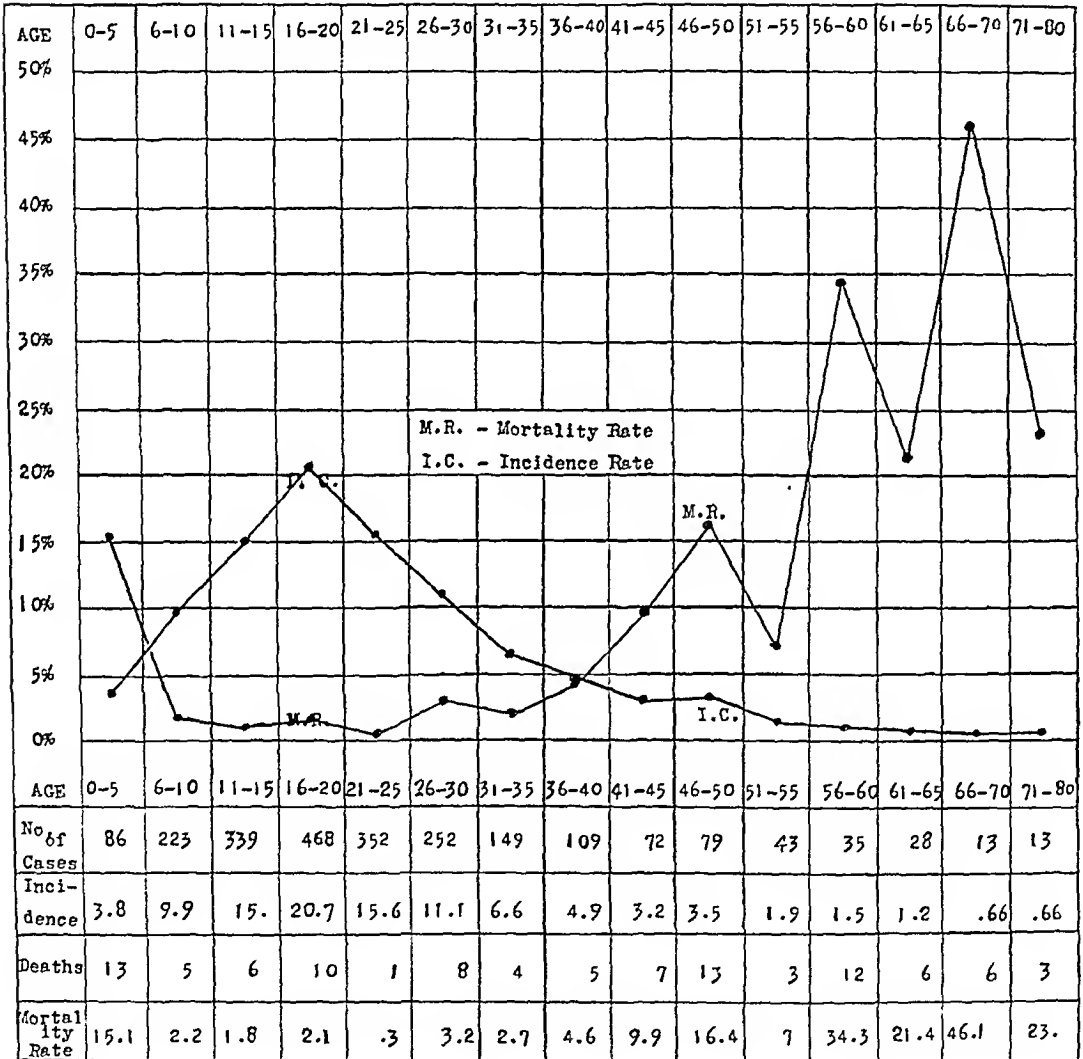
Age.—An analysis of the incidence and mortality rate by age is interesting (Graph I). The ages in this series ranged from 12 months to 80 years. It is apparent that the greatest incidence was from 16 to 20 years (20 per cent); 72 per cent of all cases occurred between the ages of 6 and 30 with an average mortality rate of 1.8 per cent. Or from another viewpoint, 44 per cent of all deaths occurred under 11 and over 55, yet only 18 per cent of all cases occurred in these age groups.

The higher mortality and lower incidence in children and elderly adults has repeatedly been discussed. The gravity of acute appendicitis in children is dependent not only upon the inherited virulence of the infection, but also upon the delay attendant upon the difficulties of diagnosis and upon the very frequent administration of drastic purgatives. All writers agree that appendicitis in children, as in adults, develops with marked rapidity once it has started. Maes, Boyce and McFetridge,⁷ in analyzing 250 cases below 12 years at the Charity Hospital, New Orleans, found that 73 per cent were complicated at time of operation by gangrene, rupture, abscess or peritonitis. Gallie found that 70 per cent of the cases of acute appendicitis in children admitted to the Toronto Children's Hospital entered with the appendix already ruptured. In the surgical treatment of appendicitis in children, it is better to operate upon a suspected case and find a normal appendix than fail to operate until the diagnosis is unmistakable and the prognosis grave.

Maes,⁷ in an analysis of 100 cases over 40 years of age, found that 77

per cent at the time of operation were complicated by gangrene, rupture, abscess or peritonitis and the operative mortality was 21 per cent. Wood,⁸ in discussing acute appendicitis in the aged, found "atypical clinical manifestations in 50 per cent, correct preoperative diagnosis in only 62 per cent and 28 per cent mortality, one-half of which were due to operative complications in the aged and one-half to complications due to the appendicitis *per se*."¹¹

GRAPH I

Incidence and Mortality by Age

Delay.—It is universally agreed that the two greatest factors in the existing mortality rate for acute appendicitis are the time interval between the onset of symptoms and operation, and the administration of cathartics, the former being more important since any delay and mismanagement implies usually some treatment and the laity have not yet learned the danger of treating abdominal pain with cathartics. Bailey¹ found a mortality rate of less than one per cent among those operated in the first 12 hours, the rate

rising to 18 per cent in those in which there was a delay in operation to 36 hours or over. Bower,⁹ in his widely known Philadelphia survey, found similar results. In our series those cases showing suppurative, gangrenous or complicated pathology were analyzed to determine the incidence and mortality according to the preoperative delay (Table III). The cases of acute catarrhal appendicitis and acute exacerbation of chronic appendicitis were not included because many of these cases presented minimal symptoms for many days and if included would obscure the ultimate conclusion.

TABLE III
Incidence and Mortality Based upon Preoperative Delay

1924-1933	0-12 hours	12-24 hours	24-36 hours	36-48 hours	48-72 hours	72-96 hours	5 days and over
Total.....	212	411	134	296	221	86	225
Incidence....	13.4%	25.9%	8.4%	18.6%	13.9%	5.4%	14.2%
Deaths.....	4	10	4	24	19	9	32
Mortality rate...	1.8%	2.4%	3%	8.1%	8.6%	10.5%	14.2%

It is at once apparent that delay is attended with marked increase in mortality. Over a ten year period only 13 per cent were operated upon within 12 hours of the onset of symptoms with a mortality rate of 1.8 per cent. Many cases, especially those with the obstructive type of appendicitis with its characteristic rapid clinical picture, are complicated within 12 hours. One of our cases was ruptured after a duration of only four hours. It is noteworthy that from 1929 to 1934, 43 per cent were operated upon within 24 hours with a mortality of 1.7 per cent compared with 33.3 per cent in the period 1924 to 1929 with a mortality of 2.1 per cent. This shows some progress in the right direction although not nearly so marked as that noted in Philadelphia following the recent extensive public health educational program.¹⁰

On the other hand, over 15 per cent of our cases had a preoperative duration averaging eight days, with a mortality of 14.2 per cent. It is noteworthy that there has been no reduction in recent years in these markedly delayed cases. The fact that 83 per cent of all our deaths occurred in cases with a preoperative delay of over 36 hours indicates this danger.

In reference to cathartics, Bowers,¹⁰ in analyzing the mortality records of 28 Philadelphia hospitals from 1928 to 1930, showed that of those taking no cathartic during the acute attack, one in 80 died; with one cathartic, one in 13 died; and of those that took two or more cathartics, one in seven died. In our own series, a history of cathartics was obtained in only 10 per cent of all cases, and 32 per cent of the fatal cases. With no cathartics, one in 28 died; with a history of one cathartic one in seven died; with a history of two or more cathartics, one in five died. Since those cases having taken one or more cathartics are usually also those cases in which extensive preoperative delay occurred, the exact danger of the cathartics cannot be evaluated although there can be no doubt but that the marked peristalsis induced by

cathartics in the presence of a tense suppurative or gangrenous appendix favors rupture, or in the presence of spreading peritonitis, favors dissemination of the infection.

Surgical Technic.—The proper surgical procedure in acute appendicitis involves many debatable points and deaths occur in every series of cases which probably could in small part have been prevented by different technic, but one should always recall that the outcome in any case or group of cases depends not so much upon the exact procedure adopted as the promptness with which it is adopted and the wisdom which correlates the pathologic process present with the extent of the surgery performed. Accordingly, the surgeon's judgment is as important as his technical skill.

In this series of cases, almost universally, operation was performed as soon as possible after the diagnosis was made. It was deferred in a few critical cases and hypodermoclyses, venoclyses and general supportive treatment given until the patient's general condition was sufficiently improved to permit surgery, but we have not followed the Ochsner treatment which in the hands of many has apparently given such satisfactory results. Le Grand Guerry,¹¹ in a very commendable series, reports a mortality of 1.6 per cent in cases of acute diffuse peritonitis in which operation was deferred (Ochsner treatment being used) compared with a mortality of 8.2 per cent in cases of acute diffuse peritonitis with immediate operation. Coller and Potter,¹³ in a recent article, show a mortality of 9.3 per cent in cases of acute diffuse peritonitis under Ochsner treatment. I believe that with the exception of acute appendicitis in children, the general condition of the patient is the best indication of the proper time to operate. In cases of acute diffuse peritonitis, a delay of several hours during which supportive treatment is given certainly improves the patient's risk, yet I believe that our mortality rate would be somewhat reduced if, in selected cases, the Ochsner treatment were instituted.

In this series, general inhalation anesthesia (gas-oxygen-ether) was almost universally used, there being 2,130 such cases. Spinal anesthesia was used in 111 cases during the last four years. There have been no deaths or apparent complications due to the use of this type of anesthesia in these cases and in many of the acutely ill, especially in elderly people, it has been markedly superior. Novocaine as a local anesthesia was used in 12 cases, avertin basal in three, and amytal basal (gr. xv) in four cases. In respect to anesthesia, each case offers its own indications or contraindications, but, in general, we believe the general inhalation anesthesia to be preferable, with spinal anesthesia of great value in selected cases.

In 71 per cent of these cases, the small McBurney incision was used, 28 per cent right rectus incision and 1 per cent midline incisions. In our experience, the McBurney incision reduces the operative time, permits adequate exposure (the incision being enlarged to a right rectus incision in the hockey stick manner if necessary), limits intraperitoneal manipulation and markedly reduces the incidence of postoperative hernia. We have never seen a post-

operative hernia in an undrained McBurney incision and in drained cases (30 per cent) there was a reported incidence of hernia in 0.9 per cent with the McBurney incision compared with 2.7 per cent with right rectus incision, an incidence three times as great.

In respect to drainage of the peritoneal cavity, excluding definite abscess formation, the attitude in recent years has changed from "when in doubt, drain," to "when in doubt, don't drain." Drainage lengthens the period of hospitalization and increases postoperative complications, such as hernia, fistula, adhesions and intestinal obstruction. At best, drains care only for localized areas, never the general peritoneal cavity. In our series, we use multiple drains at times. Soft rubber tubes, glass tubes, gauze and cigarette drains are the common materials employed. Occasionally, the rubber and glass tubes are aspirated regularly with sterile catheters. It has been our practice to enter the peritoneal cavity through the smallest possible incision, explore digitally, exteriorize the appendix if possible, clamp and tie the meso-appendix, ligate the appendix at its base, sever it with actual cautery and invert the stump with chromic or linen suture, approximating the severed meso-appendix stump to the appendiceal area and routine layer closure. If the appendix cannot be delivered into the wound or if rupture and peritonitis exist, the incision is made adequate, the operative area protected by laps and the appendix removed in the easiest manner, often being "backed out." Peritoneal fluid, exudate or pus is sponged or aspirated, the pelvis and lateral gutter being sponged or aspirated for collections of fluid. In recent years only those cases are drained in which there is macroscopic purulent fluid or cases in which inflammatory necrotic tissue will probably form a slough, or in which considerable oozing is contemplated. Frequently, multiple drains are used, often of combined types and often by separate stab wounds to the pelvis and lateral paracolic gutter. In cases of abscess formation or diffuse generalized peritonitis, the appendix is removed if accessible with only moderate difficulty. We agree with Quain and Waldschmidt¹⁴ that "when the cause is removed, the patient has a better chance to overcome the damage already wrought on the peritoneum" except when its removal may cause the tragedy of the conversion of a localized abscess into a generalized peritonitis by the breaking down of protective adhesions. In these latter cases, *i.e.*, appendiceal abscess in which appendectomy may not be easily performed, drainage only is instituted and secondary appendectomy later performed. As seen in Table IV, 41 such cases were operated upon, with a mortality of 9.7 per cent, and of these there were 11 recorded secondary appendectomies without a single death. McGrath and Eiss¹⁵ have recently reviewed this attitude both pro and con and believe that "in acute appendicitis, it is not enough to merely save life; the aim should be to restore the patient to complete health and efficiency with as little delay as possible" and advise dissection and removal of the appendix even under the most unfavorable conditions.

TABLE IV
Mortality According to Operative Procedure

Procedure	No.	Mortality	
		Deaths	Rate %
Appendectomy.....	1,580	10	0.63
Appendectomy with drainage.....	630	75	11.9
Drainage of abscess only.....	41	4	9.75
Drainage and enterostomy.....	1	1	100
Appendectomy with drainage and enterostomy.....	8	7	87.5
Died without operation.....	—	5	—

(No essential difference by years.)

In the selection of drainage material, there exists a marked divergence of opinion. McGrath and Eiss¹⁵ employ rubber tissue, avoiding rubber tubing since it is liable to produce a fecal fistula, and believe gauze is unsatisfactory because, instead of draining, "it blocks drainage and thus encourages multiplication of infection." On the other hand, Arnheim and Neuho⁴ use iodoform gauze with rubber tissue and have very appreciably lowered their mortality.

The attitude towards drainage will probably change radically in the next decade. Muller¹⁶ does not drain for turbid fluid even if spreading peritonitis exists. Some surgeons in cases of diffuse peritonitis merely insert non-absorbable metal sutures including all layers, not tying until drainage ceases; others close the peritoneum but drain the fat layer. The results of this new procedure will be of interest.

In respect to cultures of the peritoneal fluid, Muller¹⁶ states that "they are unreliable for exact diagnosis and unnecessary, because of the great amount of work required for proper study." Meleney¹⁷ found "B. coli, green streptococci and B. welchii the organisms most commonly found but there seemed to be no association between the type of organism and the severity of the lesion, but rather it is the dosage of those organisms and the presence of irritating intestinal juices that determines the fatal outcome."

Appended is a summary of the causes of death in the cases of both acute and chronic appendicitis.

Acute appendicitis—Total deaths.....	102
Generalized peritonitis.....	52
General peritonitis and intestinal obstruction.....	8
Intestinal obstruction without peritonitis.....	2
Cardiac decompensation with peritonitis.....	4
Cardiac decompensation without peritonitis.....	9
Intramural thrombosis (autopsy).....	2
Lobar pneumonia.....	12
Bronchopneumonia.....	1
Pulmonary TBC (pelvic abscess).....	1
Pulmonary embolism.....	6
Empyema (general peritonitis).....	1
Suppurative pyelophlebitis (liver abscess).....	1

Poliomyelitis	1
Diabetes with general peritonitis	1
Gas gangrene of abdominal wall	1
Chronic appendicitis—Total deaths	8
General peritonitis	2
Lobar pneumonia	3
Bronchopneumonia	1
Pulmonary embolism	1
Intestinal obstruction (enterospasm—autopsy)	1

It is to be noted that 65 per cent died of intraperitoneal suppuration and 35 per cent of some distant complication. Five of these deaths occurred without operation; 19 died within 24 hours of operation of peritonitis; and five died over three weeks after operation, one of lobar pneumonia, uremia and diabetes mellitus,—one of empyema and peritonitis on the thirtieth day, one of cardiac decompensation and bronchopneumonia on thirty-fifth day, one of pulmonary tuberculosis and pelvic abscess on forty-ninth day, and one of lobar pneumonia on the eighty-sixth day postoperative. Four deaths were associated with pregnancy. The following summary of the cases complicated by this condition is interesting:

	First Trimester	Second Trimester	Third Trimester
Pregnant.	14	7	5
Recovered	13	5	4
Abortion...	4	3	1
Died..	1	2	1

Among the postoperative complications, the following are noteworthy:

Undrained cases: abscess formed which necessitated secondary drainage—four cases. General peritonitis occurred in two cases.

Drained cases: abscess formed which necessitated secondary drainage—nine cases. Fecal fistula occurred in eight cases (0.3 per cent). Phlebitis occurred in ten cases (0.4 per cent).

SUMMARY

The author has reviewed 4,791 consecutive appendectomies from 1924 to 1934, inclusive, including 2,260 cases of acute appendicitis, analyzing these in various aspects and briefly summarizing the recent literature in respect to the individual points analyzed.

The mortality rate in acute appendicitis, based upon vital statistics, has been gradually rising, but the mortality rate based upon hospital surgical case reports has been gradually falling, although it still constitutes a challenge to the medical and surgical profession.

The two greatest preventable factors in this mortality are the delay in operation and the administration of cathartics. The laity need to be further impressed that the ice bag has no influence on pathology and that it may be dangerous to administer cathartics in cases of abdominal pain.

There exist many debatable factors in the surgical technic employed in cases of acute appendicitis, the solution of which will partially reduce the

existing high mortality rate, but the outcome in any case or group of cases depends not so much upon the exact surgical procedure adopted as upon the promptness with which it is adopted and the wisdom which correlates the pathologic process present with the extent of the surgery performed.

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SPINA BIFIDA

TREATMENT AND ANALYSIS OF EIGHTY-FOUR CASES

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THE following study is an analysis of eighty-four cases of congenital malformation of the brain and spinal cord associated with defects of the cranium and vertebral column. The material is taken from the Children's Surgical Service at Bellevue Hospital covering a period of fifteen years from 1919 to 1934. These cases are reviewed in order to correlate the clinical findings with the subsequent course, to ascertain the proper selection of cases for operation and the suitable operative procedure. Forty-seven or 56 per cent. of the patients were considered inoperable, of these thirty-three died within the first four weeks of life, thirteen died before the end of two months and only one was alive at the end of a year. Of the thirty-seven or 44 per cent. of the patients operated upon, ten died while in the hospital. Twenty-seven children survived the operation and have been followed from two months to ten years.

From a study of the literature there is apparently no unanimity of opinion as to the indication for operation, time to operate or correct operative procedure. These observations and conclusions with regard to the different varieties of spina bifida are made in the hope of adding greater clarity with regard to certain of the debated points in the management of this grave congenital affection. The gratification of the surgeon in treating this dreaded condition is in seeing some of these infants advance in years without physical or mental impairment or with but slight permanent handicap.

No case was considered inoperable unless the herniation ulcerated and cerebrospinal fluid exuded, or there was a progressively increasing hydrocephalus, or the patient was hopelessly crippled and deformed so as to render corrective procedure aimless. However, the presence of a slowly progressive hydrocephalus and an ulcerating tumor and leaking cerebrospinal fluid did not in all cases preclude operative intervention as illustrated by the following case report.

CASE I.—(Figs. 1A, 1B, 1C, and 1D.) Soon after birth, hydrocephalus increased simultaneously with the enlargement of a right-sided sacral myelomeningocele which was the size of a small grapefruit. More than half of the surface consisted of a tense, red, thin parchment membrane which ulcerated and subsequently discharged cerebrospinal fluid. With the escape of the latter the size of the head appreciably diminished. Following the closure of the sinus in the sacral protrusion the head increased in size, the fontanelles bulged and soon thereafter the parchment-like membrane ruptured and cerebrospinal fluid escaped. This sequence of events occurred four times within five months. For one month thereafter there was no further enlargement of the skull. The surface of the sac remained dry and no cerebrospinal fluid escaped. A Penfield-Cone

operation was performed, the entire dura and nerve filaments being reflected into the defect in the spinal column and covered with reflected fasciæ. For a period of two months

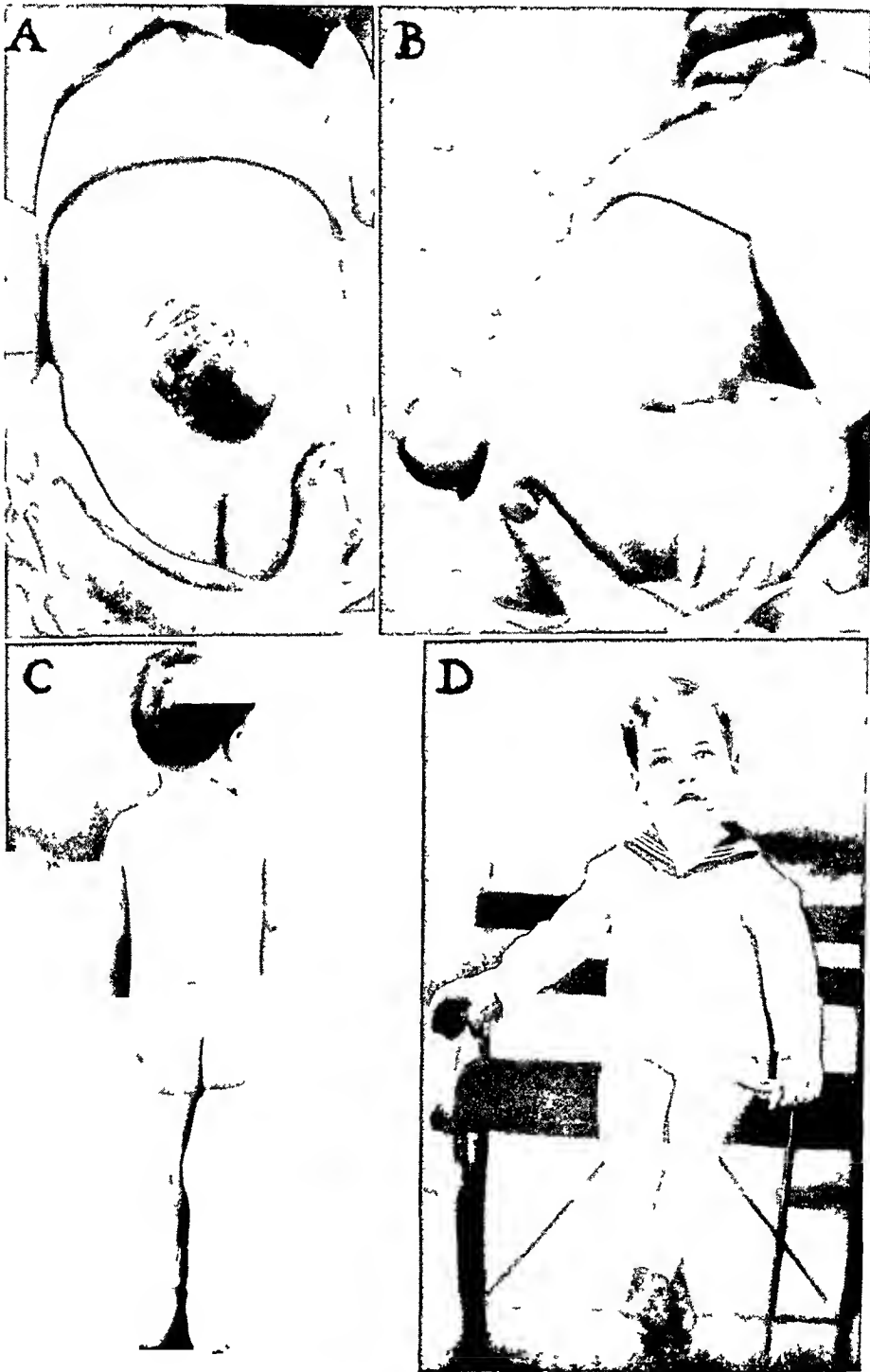


FIG. 1.—(Case I) (A) Sacral myelomeningocele. Taken two days before the operation when the child was six months old, showing the extent of the protrusion and ulceration. (B) Lateral view of same protrusion. (C) Photograph taken eighteen months after the operation. There is no evident recurrence of the protrusion. (D) Child two years old. No evidence of hydrocephalus.

there was a slight but appreciable increase in the size of the skull. Thereafter no obvious expansion occurred and the child has been followed for eighteen months, is now two

years old, mentally alert and has no apparent physical impairment other than some vesical incontinence which is becoming less.

CAUSES OF SPINA BIFIDA.—According to Frazier,¹ the one feature common to all varieties of spina bifida is the imperfection in the mesoblast. Many theories have been advanced as to the contributing factors in the cause of this anomaly: namely, (a) that these hernial protrusions from the vertebral column or cranium are primarily due to a defect in the bone; (b) that there is a derangement of the brain which causes an increase of the cerebrospinal fluid; (c) that there is an obstruction to the normal passage of cerebrospinal fluid, and (d) that the absorption of cerebrospinal fluid is incomplete, resulting in an hydrocephalus. There is yet no conclusive evidence to indicate which is the dominant factor, or indeed that there is a single dominant factor, as evidenced by the presence of hydrocephalus and the absence of fusion and ossification in utero of the mesoblastic plates containing the rudimentary laminae. The failure of the cranial bones and the vertebral arches to close may be the result of an incipient hydrocephalus in utero, the bony defect serving as a vent for the increased spinal fluid which must either expand the cranial bones and increase the bulging fontanelles or else find some other outlet for the ever-increasing fluid pressure at some weakened point in the cranium or spinal column. It is very probable that the size of the bony defect depends on how soon the internal pressure of the increased cerebrospinal fluid has become manifested in utero and finds a vulnerable place in the bony structure which has not yet fused and become ossified.

CLASSIFICATION OF SPINA BIFIDA.—In grouping the cases of spina bifida cystica we have followed the classification of Von Recklinghausen,² and to further simplify the tabulation we have divided them into three separate entities, namely, meningocele, myelomeningocele and syringomyelocele. (Tables I, II, III, and IV.)

TABLE I
Sex Incidence

	Male	Female
Occipital.....	9	5
Cervical.....	1	2
Dorsal.....	2	4
Lumbar.....	27	21
Sacral.....	7	6
	—	—
	46	38
Total.....	84	

TABLE II
Sex—Location

	Male	Female
Occipital.....	2 meningoceles 7 myelomeningoceles	2 meningoceles 3 myelomeningoceles
Cervical.....	1 meningocele	2 meningoceles

TABLE II *Continued*

	Male	Female
Dorsal.....	1 meningocele 1 myelomeningocele	1 meningocele 2 myelomeningoceles 1 syringomyelocele
Lumbar.....	5 meningoceles 21 myelomeningoceles 1 syringomyelocele	5 meningoceles 15 myelomeningoceles 1 syringomyelocele
Sacral.....	1 meningocele 6 myelomeningoceles	6 myelomeningoceles
	— 46	— 38

No cases of spina bifida occulta were included in this series, although two such cases were recognized, one by a dimple and the other by a tuft of hair in the lumbar region. They were admitted to the hospital for acute surgical conditions, bearing no relation to the defect in the spine and they presented no neurological signs. The diagnosis was corroborated by visible vertebral defects on radiographical examination. Neither case presented evidence of impairment of vesical or rectal function.

Meningoceles.—The nineteen children with meningoceles presented the following findings. In eleven children the dural protrusions were covered with skin which appeared to be normal in texture. (Table V.) The skin covering the other eight of these meningoceles was under considerable tension so as to resemble a thin parchment membrane which not infrequently was transparent and simulated a myelomeningocele. The herniation varied in size from that of a small walnut to the size of the infant's head depending on the extent of the intraspinal and intracranial pressure. The extent of the skeletal defects ranged from that of a pinpoint opening in the incompletely fused laminae to the complete absence of one or more of the arches in the spine. The cranial defect was a circumscribed opening which in no case was larger than a quarter. The largest meningoceles were observed at the base of the occipital bone and the smallest in the dorsal region. Large dural protrusions in at least 30 per cent. of the cases received their cerebrospinal fluid through minute openings in the cranium or vertebral column. The diameter of the saculation bore no direct proportionate relation to the size of the defect in the bony framework.

Myelomeningoceles.—While fundamentally the nature of this disease was the same as that of meningoceles, it differed in that the bony defects were more extensive and presented disabilities and symptoms because of the presence of nerve filaments or brain substance in the dural sac. (Tables V and VI.) The following observations were made in the forty-two cases of myelomeningoceles. The skin covering the protrusion in twenty-three children was thinned out, translucent and cystic. The sac in three of these children had spontaneously ruptured at birth with the escape of cerebrospinal

TABLE III												
<i>Age on Admission</i>												
	1 to 7 days	8 to 15 days	15 to 28 days	5 to 8 wks.	2 mos.	3 mos.	4 mos.	5 mos.	6 mos.	7 mos.	1 yr.	2 yrs.
Occipital.....	7	3	1			1	1					3
Cervical.....		2										1*
Dorsal.....	4				1	1						
Lumbar.....	24	5	5	3	3	1	1		2	1		2
Sacral.....	4	2	1	1	.			1		1	1	1
* Orbital.												

TABLE IV												
<i>Age Operated</i>												
Occipital.....	4	2			1		1					1*
Cervical.....		2										
Dorsal.....	1		1		1							
Lumbar.....	5	5	1	2	2					1		1
Sacral.....		1	1	1					1		1	1
* Orbital.												

TABLE V
Condition of Hernial Protrusions

		Firm Integument	Cystic	Ulcer- ated	Cerebro- spinal Fluid Exuding	In- fected
Cranial.	(4) Meningoceles operated.....	1 orbital	3			
	(5) Encephaloceles operated.....		5			
	(5) Encephaloceles inoperable....		1 1*	3 1*		1*
Cervical	(2) Meningoceles operated.....	2				
	(1) Meningoceles inoperable.....	1				
Dorsal..	(2) Meningoceles operated.....	1	1			
	(1) Meningomyelocele operated...		1*	1*		
	(2) Meningomyeloceles inoperable			2		
	(1) Syringomyelocele.....			1		
Lumbar	(8) Meningoceles operated.....	5	1 2*	2*		1*
	(2) Meningoceles inoperable.....	1		1*	1*	1*
	(9) Meningomyeloceles operated..		4	3	2	
	(27) Meningomyeloceles inoperable		3	21	3	
	(2) Syringomyeloceles inoperable.		1* 1	1* 4	1* 4	1*
Sacral..	(1) Meningocele operated.....	1				
	(5) Meningomyeloceles operated..	2	1 1* 1*	1* 1*		
	(7) Meningomyeloceles inoperable	2	1 4*		1*	

* Indicates more than one complication of the integument in the same case.

TABLE VI
Associated Conditions Other Than Hydrocephalus

	Paraplegia	Talipes	Loss of Sphincters	Prolapse of Rectum
Cranial.....				
Cervical.....	1 meningocele*			
Dorsal.....	1 syringomyelocle		1 syringomyelocle	
Lumbar.....	12 myelomeningoceles* 2 syringomyelocles	12 myelomeningocles 2 syringomyelocles	2 myelomeningoceles 2 syringomyelocles	1 myelomeningocle 1 syringomyelocle
Sacral.....	2 myelomeningoceles	3 myelomeningocles	1 myelomeningocle	1 myelomeningocle
	17	17	6	3

* One child had both a cervical meningocele and a lumbar myelomeningocele.

fluid resulting in a flabby saculation. In eight cases the sacs became ulcerated and in six cases a small sinus appeared simultaneously, from which cerebrospinal fluid exuded. This was generally followed by infection and an ascending meningitis. Occasionally with the escape of the cerebrospinal fluid the sac collapsed and the sinus walls coalesced and the perforation would close. With the decrease in the size of the sac the intracranial pressure was temporarily diminished, causing a recession of the bulging fontanelles. A period of readjustment of cerebrospinal fluid pressure would take place and the sac would not fill up to the dimensions observed before the perforation. In some patients the firm integument made the condition indistinguishable from meningoceles unless there was an obvious impairment in function of the nerve-roots. Nor did the presence of a few nerve-roots in the dural sac distinguish the subsequent course from that of a simple meningocele until months after the operation when the inability of the child to walk was discovered and vesical and rectal incontinence manifested themselves. Seventeen children were born with paralysis of their lower extremities. The presence of the spinal cord, nerve-roots or brain substance generally occurred through a broader bony defect and in these instances the summit of the fluid-filled protrusion was somewhat flattened and longer in the cephalic direction and appeared dimpled on its summit. This was not observed in the cases of encephaloceles. Hydrocephalus, congenital deformities of the extremities and bladder and rectal paralysis were more frequently observed in the children in whom the sacs had flattened surfaces than in the globular herniations. Ascending meningitis from ulcerating and leaking protrusions developed more readily in myelomeningocele than in meningoceles. One child had a sacral myelomeningocele complicated by an eventration of the lower anterior abdominal wall and evisceration of the abdominal contents. We have been unable to find a record of a similar case in the literature.

Syringomyelocele.—The most disastrous group of cases were the syringomyeloceles. None of these patients were operated upon and all of them died within a month after admission. The defect in the vertebræ generally affected more than one lamina which was either absent or split. The defect included part or all of the spinal cord and nerve-roots giving the appearance of an excavation of the vertebral column. In two cases a large section of the vertebral column was entirely open without any coverings. These cases were complicated by deformities, hydrocephalus and sensory and motor disturbance with impairment of sphincter control. No case of cranioschisis was observed in this series.

Hydrocephalus.—The presence of hydrocephalus and the possibility of precipitating an acute hydrocephalus by the amputation of the sac was a dominant consideration in the treatment of all cases that might be amenable to surgery. (Table VII.) Hydrocephalus was present in nine of the thirty-seven children before they were operated upon, of which six were meningoceles and three were myelomeningoceles. Eight, of the thirty-two children in whom the sac was amputated, had hydrocephalus before their operation and it was increased in seven of these children after this procedure. Hydro-

TABLE VII
Hydrocephalus

	Hydrocephalus Present at Birth	Progressive Increase Developed after Amputation of Sac	Hydrocephalus Not Present before Operation. Devel-oped after Amputation of Sac	Fol-lowed	Died	Fol-lowed	Hydrocephalus Increased after Preservation of Sac	Deaths in Children with Hydrocephalus Who were Not Operated on
Cranial.....	1 M* oper.* 4 MM* no oper.*	yes for 3 yrs.		Fol-lowed 10 yrs.				4
Cervical.....	1 M oper. 1 MM no oper.	no		7 yrs.				1 wk.
Dorsal.....	1 SM* no oper.							2 wks.
Lumbar.....	1 M oper. 1 M oper. 1 M oper. 1 M oper. 1 MM oper. 1 MM no oper. 1 MM no oper. 1 MM no oper. 1 MM no oper. 1 MM no oper.	yes yes yes yes		2 mo. 1 yr.	1 yr. 20 days 10 wks.			3 mos. 4 wks. 5 wks. 4 mos. 7 mos.

cephalus, which was not previously present, developed in four of the thirty-two children in whom the dural and arachnoid protrusion was amputated. Hydrocephalus which was present before operation was temporarily increased in one of the children in whom the sac was preserved and was not precipitated in the other four children in whom the membranes were not excised. The twenty-four children in whom there was no preëxisting hydrocephalus and who did not develop hydrocephalus after the operation while in the hospital were subsequently followed from two months to ten years without external evidence of increased intracranial pressure. The five myelomeningoceles in whom the sac was preserved and who were followed for five months to two and one-half years were operated upon by the method advocated by Penfield and Cone.³ They substantiated clinically their experimental observations that the amputation of the sac bore a direct relation to the absorption of spinal fluid and recommended the preservation of the dural sac. They agreed with Cutler,⁴ that hydrocephalus was either potential or existed with the hernial sac as a safety valve for the absorption of the increased cerebrospinal fluid.

ANALYSIS OF RESULTS

CRANIAL-BIFIDÆ.—There were fourteen children, or 16.8 per cent. with cranio-bifidæ. (Tables VIII and IX.) Four cases were meningoceles and

TABLE VIIIA

Total	Per-centage		Meningoceles			Myelomeningoceles			Syringomyeloceles
			Total	Oper-ated	No Op-eration	Total	Oper-ated	No Op-eration	
14	16.8	Cranial	4	4		10	5	5	
3	3.5	Cervical	2	2	1			1	
6	7.1	Dorsal	2	2		3	1	2	1
48	57.1	Lumbar	10	8	2	36	9	27	2
13	15.5	Sacral	1	1		12	5	7	
84			19	17	3	61	20	42	3

TABLE VIIIB

Meningoceles	20
Myelomeningoceles	.		61
Syringomyeloceles		.	3
			84

TABLE VIIIC

Operations			No Operation		
Meningoceles	.	17	Meningoceles	.	3
Myelomeningoceles		20	Myelomeningoceles	..	41
Syringomyeloceles		0	Syringomyeloceles		3
		37—44%			47—56%

Results.—25 of the 37—67.6 per cent survived. 12 of the 37—32.4 per cent died.

TABLE IX

Follow-Up of Patients Operated Upon

	2	2½	3	5	7	10	12	15	18	22	2	2½	4	7	10
	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	mos.	yrs.	yrs.	yrs.	yrs.	yrs.
Cranial..			2				1								1
Cervical.							1							1	
Dorsal...				1		1		1							
Lumbar.	3	1	1				3	1	3			1			1
Sacral...					1					1	1		1		
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	3	1	3	1	1	1	5	2	3	1	1	1	1	1	2

ten were encephalomeningoceles. Of the four meningoceles all of which were operated upon, three were posterior and one was situated in the orbital region. One infant who was four days old at the time the occipital meningocele was excised died two days later from meningitis without evidence of hydrocephalus. Of the other three children who were operated upon one was followed for ten years and two of the children returned for three months. The child who was followed for ten years (Case II) (Figs. 2A, 2B, 2C and 2D) presented in the occipital region a large fluctuant tumor the size of an orange with small vesicles in the skin at its base. The sac was thin, blue in color with bulging vessels which were particularly prominent when the child cried. An operation was performed when the infant was six days old at which time the dural sac containing only cerebrospinal fluid, was excised down to the defect in the skull which was about one inch in diameter. The wound healed by primary union. Soon thereafter a moderate hydrocephalus developed. This receded and recurred to an appreciable extent until the child was about three years old. Thereafter there was no increase in the size of the head which would be considered out of proportion to the growth of the child who has been seen at yearly intervals. His mentality is normal and there is no physical impairment. The third infant was three months old on admission and presented a papillomatous fluctuant occipital meningocele which was four inches in diameter. The sac was amputated. No hydrocephalus developed nor has there been any evidence of recurrence. The child with the orbital meningocele was three years old on admission. He presented a swelling over the bridge of the nose which was fluctuant and tense and was mistaken for a dermoid. At operation the pedicle led to the region of the inner canthus of the right orbit from which cerebrospinal fluid exuded. This fluid drained for seven days. There has been no recurrence during the three months that the child has been followed.

Five of the ten encephalomeningoceles were operated upon and five were considered as inoperable. Of the five children operated upon two died from shock. The other three infants died from meningitis, two, eleven and twenty days after surgical intervention. Considerable brain tissue was present in the sacs of all five children operated upon. In two patients the brain tissue was replaced, in two the protruding cerebellum was resected as it could not be replaced and in the fifth case the condition was found too extensive to

return into the cranium. Of the five children with encephalomeningoceles upon whom there was no surgical intervention, one had a tumor the size of a lemon with a tremendous hydrocephalus which rapidly increased in size. The child died within three months. The second infant presented a grape-

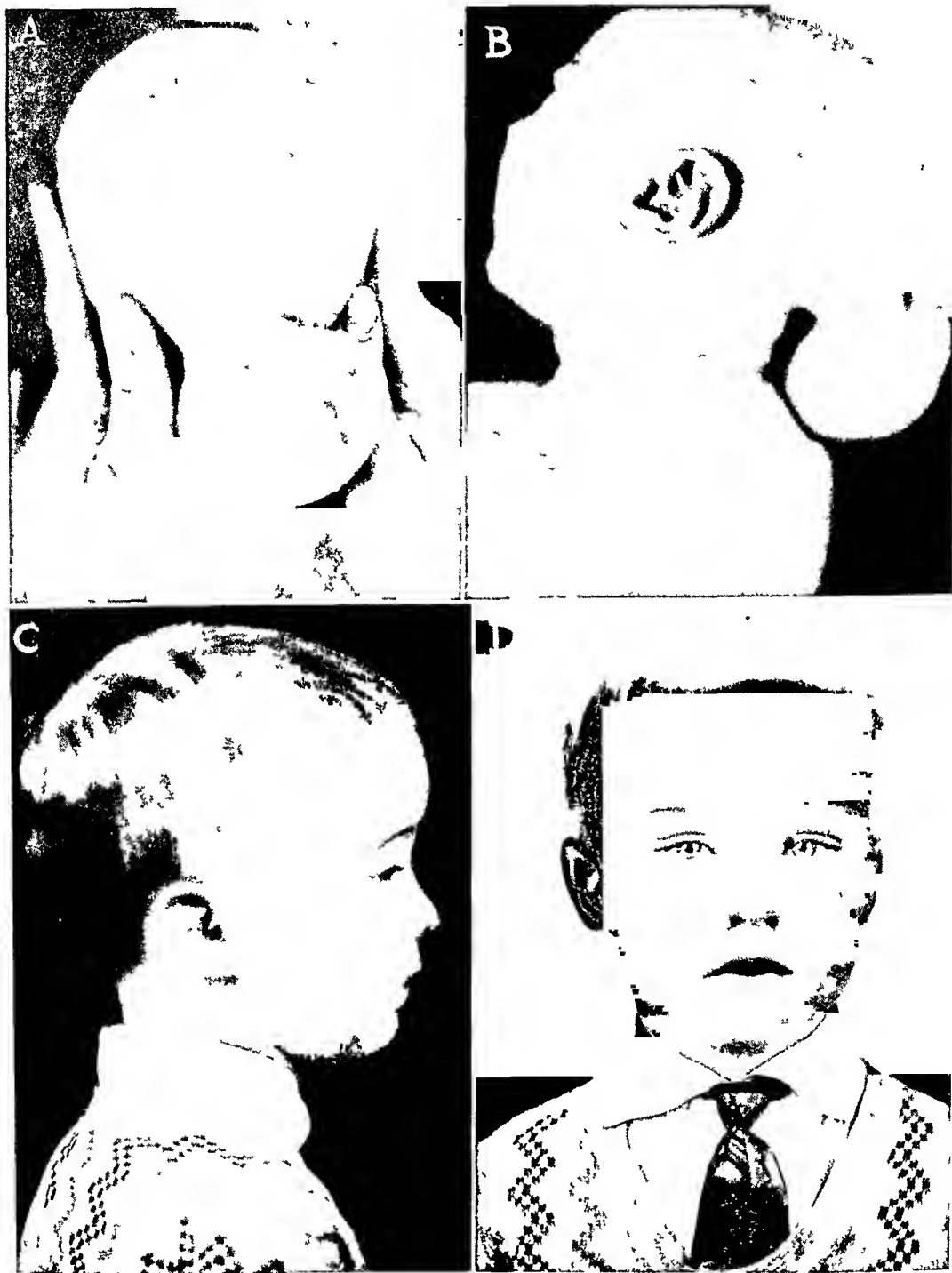


FIG. 2—(Case II). (A) Photograph of a case of occipital meningocele taken when the child was five days old. (B) Lateral view of the same case. Child operated upon when he was six days old. (C) Lateral view of the boy when he was six years old. There is no evidence of recurrence. (D) Anterior view taken at the age of six years. There is no evidence of hydrocephalus. The patient has been followed for ten years.

fruit sized cerebellar herniation, which ulcerated and became infected, and the child died of meningitis. Two of the children succumbed from progressive hydrocephalus which became very pronounced and gave the children the appearance of monstrosities. In the fifth case there was a soft flabby encephalomeningocele which was ulcerated and complicated with hydrocephalus. This child died twenty-one days after birth from gastroenteritis and an ascending meningitis.

Cervical Spina Bifida.—The three cervical spina bifidæ which comprised 3.5 per cent. of all of the cases were children with meningoceles. One child was nine days old and also had a larger myelomeningocele in the lumbar region. The mass in the cervical region was the size of a small orange, soft, puffy and fluctuating while the larger sac over the fourth lumbar region was transparent, ulcerated and receded with inspiration. There was present a moderate degree of hydrocephalus. The child developed an ascending meningitis and died one week later. Of the two other meningoceles one patient was two weeks old on admission and presented a mass the size of a hen's egg which protruded through the fifth cervical vertebra. There was a moderate hydrocephalus and bulging of the fontanelles. The sac was amputated and the hydrocephalus did not increase after the operation. The child is now seven years old without any mental abnormalities. The other patient with a meningocele was eight years old, mentally deficient and afflicted with a spastic paraplegia. At operation no nerve filaments were found in the amputated sac which protruded through a defect in the fifth and sixth cervical vertebra. One week later the hernial protrusion recurred and became ulcerated. It eventually healed but was not re-operated upon. This patient was followed for a year without evidence of hydrocephalus.

Dorsal Spina Bifida.—There were six dorsal spina bifidæ, or 7.1 per cent. of the eighty-four cases. Of these, two were meningoceles, three myelomeningocele, and one was a syringomyelocele. Three of these patients died without being operated upon. Two were children with myelomeningocele, one child who was a week old on admission had an ulcerated leaking dura, and the other child who was one day old on admission lived six days with an infected ulcerated sac. Both of these infants developed meningitis. The third patient which died without surgical intervention had a syringomyelocele; she was two months old on entering the hospital with an ulcerated hernial protrusion which extended from the twelfth dorsal to the first lumbar vertebra, associated with hydrocephalus and complicated by meningitis. Of the three patients operated upon two had a meningocele and one a myelomeningocele. One of the children with a meningocele was three days old and presented a soft cystic pedunculated mass the size of an orange which involved the fifth and sixth dorsal vertebræ and presented no neurological symptoms. The sac was amputated two days after admission. The child was followed for fifteen months without developing hydrocephalus or any untoward symptoms. The other child with a meningocele was three months

old with the tumefaction the size of a walnut in whom the overlying skin was in good condition. The sac was amputated. No hydrocephalus developed. The child was followed for five months without any abnormalities developing. The third patient (Case III, Figs. 3A, 3B and 3C) had a myelomeningocele which was operated upon twenty-one days after birth. The sacculation was the size of an orange with a thin integument. It had ruptured before admission and exuded cerebrospinal fluid. The sac was exposed under a cradle to the heat of a carbon light. The wound closed and the protrusion increased moderately in size. No hydrocephalus developed. The child developed gastroenteritis. At operation the sac and nerve filaments were preserved. The wound became infected and was again exposed to a heating lamp. The gastroenteritis recurred. The wound subsequently healed and the child was well on discharge from the hospital. She has been followed for ten months without any untoward symptoms or evidence of hydrocephalus.

Lumbar Spina Bifida.—Patients with lumbar defects made up forty-eight cases, or 57.1 per cent. of the spina bifidæ. Of these ten were cases of meningoceles of which eight patients were operated upon and two were considered inoperable. There were thirty-six children with myelomeningoceles, of which nine were operated upon and twenty-seven were thought to be inoperable. Two patients with syringomyeloceles were not considered operable. Four of the lumbar myelomeningoceles involved the first sacral segment. The skin covering the dura of the two meningoceles which were inoperable, was normal in one of the children, while in the other it was ulcerated and cerebrospinal fluid exuded. In the latter case the patient died of meningitis from the ulcerated and infected sac, while the other child was followed for one year; the mother observing no symptoms refused to bring the child to the clinic. The condition of the sac in eight of the meningoceles which were operated upon was as follows: in five the integument was good, in three the skin was thin and cystic, two of which became ulcerated. Hydrocephalus was present before and increased after the amputation of the sacs in four of the eight children with meningoceles. One child was followed for two months at the end of which time cerebrospinal fluid was found to be exuding from the operative wound; the second child's head increased rapidly in size after surgical intervention and died on the twentieth day from erysipelas; the third child lived for a year with a progressively increasing hydrocephalus and died from bronchopneumonia complicating measles; the fourth child, in whom hydrocephalus progressed further after the excision of the protruding dura, was followed for one year at which time there were no untoward symptoms. The fifth child died on the seventh day of meningitis following amputation of the sac. The remaining three of the eight children who were operated upon by amputation of their meningoceles were followed for eighteen months with no evidence of hydrocephalus or other disturbances of the cerebrospinal system.

The condition of the sac in the thirty-six cases of lumbar myelomeningo-



Fig 3—(Case III.) (A) Dorsal myelomeningocoele Photograph taken when child was twenty one days old Note perforation of dural sac. (B) Lateral view showing extent of the base of the tumor. (C) Photograph taken eleven months after operation showing extent of operative wound There is no evidence of hydrocephalus.

celes was as follows: of the twenty-seven children who were not operated upon the herniation was ulcerated in twenty-one, cystic and flabby in three and cerebrospinal fluid exuded from three. The sac in the nine cases of myelomeningoceles in whom operation was performed presented an ulceration in three, a cystic and flabby appearance in four, and cerebrospinal fluid escaped in two. Hydrocephalus was present at birth in only one of the patients operated upon and in eleven who were not subjected to surgery. Hydrocephalus developed in only four of the nine patients in whom the sac was excised. Paralysis of one or more of the lower extremities was present in nine of the unoperated children, and in three of the children operated upon. Talipes equinus of one or both extremities was present in ten of the unoperated and two of the children operated upon. Marked prolapse of the rectum was present in one of the children operated upon and in one of the unoperated cases. One lumbar myelomeningocele was complicated by a cervical myelomeningocele and hydrocephalus previously referred to. Of the twenty-seven myelomeningoceles that were not operated upon, nineteen died from infection extending to the meninges, two from bronchopneumonia, and six from progressive hydrocephalus. Twenty-one children died within one month after birth, five within six months and one at the end of a year. Of the nine cases of myelomeningoceles that were operated upon, hydrocephalus followed the amputation of the sac in four; of these one lived for two months; another child with an associated bilateral equinus died within a month; the third lived two months with a flaccid paralysis of the extremities, and the fourth lived for twenty-nine months with paralysis of the left leg and partial paralysis of the right. One child died of meningitis and another of bronchopneumonia. Two children were followed for two months and one for eight years without any impairment other than a slight talipes equinus which was much improved with the application of a brace (Case IV, Figs. 4A, 4B, and 4C). The two children with lumbar syringomyelocoeles were deemed inoperable. One was a boy three months old who was admitted with a large thin sac with a broad base. The summit was retracted and red. Radiographical examination revealed a defect of the lumbar arches and first sacral segments. The extremities were paralyzed and there was a prolapse of the rectum. Cerebrospinal fluid exuded from the wound which became ulcerated and infected and meningitis followed. The other case was a month old boy with a large cystic mass excavated and thin involving the lumbar and lower dorsal regions. There was a moderate hydrocephalus, an exudation of cerebrospinal fluid from the protrusion and a flaccid paralysis of the lower extremities. Operation was not undertaken and the child was taken to another hospital where he died a month later from a progressive hydrocephalus and meningitis.

Sacral Spina Bifida.—There were thirteen cases or 15.5 per cent. of sacral spina bifida of which one showed a meningocele and twelve myelomeningoceles. Seven children with myelomeningoceles were considered inoperable; all seven died within a period of seven months, three of whom died twenty-



Fig. 4—(Case IV.) (A) Lateral view of the lumbar myelomeningocele taken when child was two weeks old, at which time he was operated upon. Note ulcerated area. (B) Lateral view of child's head when he was eight years old. There is no evidence of hydrocephalus. (C) Photograph showing the scar retracted, with no evidence of recurrence. The child has been followed for ten years.

four hours after admission to the hospital. One of these children presented a mass over the left buttock which was four inches in diameter and was covered with normal skin. This condition was complicated by a large eventration of the anterior abdominal wall including all of the intestines. The thin transparent peritoneum overhung the genitalia and was further complicated by clubbing of the feet. The child died soon after birth. Three of the six inoperable children died from progressive hydrocephalus and the other three died from infection of the ulcerated hernial protrusion which resulted in meningitis. Of the six children that were operated upon five had myelomeningoceles and one had a simple meningocele. Two of the cases of myelomeningocele died; one child, who was twenty days old discharged cerebrospinal fluid from the sac which was red and ulcerated. The sac which was freed of its nerve filaments was amputated and the infant died of meningitis two days later. The other myelomeningocele which died was six weeks old on admission and presented an hydrocephalus with a soft cystic mass the size of an orange. At operation the nerve filaments were replaced and the sac was amputated. The child died twenty-one days later from a progressively increasing hydrocephalus. Death was inevitable although there was a remote possibility that the hydrocephalus would remain arrested after the operation. Of the three children with myelomeningoceles that survived their operation, in one the sac was amputated and in the other two the sacs were preserved. The sac was amputated in a child who was three years old on admission to the hospital at which time he presented a circumscribed swelling four inches in diameter over the sacral region extending over to the right and which was covered with thick skin. The tumor appeared lobulated and was of a doughy consistency simulating a lipoma. At operation the fine filaments of nerves were separated from the sac and replaced into the small defect in the bone. The sac was excised. After the operation there was a suppression of urine which necessitated frequent catheterization. Subsequently the patient continuously wet and soiled her linens with urine and fæces as she had done before the operation. She has been followed for four years. By diligent training the patient will avoid soiling her clothes if she is reminded to urinate every two or three hours. She is unable to sleep through the night without wetting her bed. The patient is very constipated, several days will pass without defecation unless she is given an enema. She occasionally experiences a fullness in her lower abdomen due to pressure of the fæces of many days accumulation. She manages very well at school and participates in all activities.

Of the two patients with sacral myelomeningoceles in whom the sacs were preserved, one (Case I) referred to previously, is now two years old. The other child (Case V), (Figs. 5A, 5B, 5C and 5D) was operated upon when he was two weeks old. The skin over the protruding sac was firm in texture and extended from the posterior superior spine to the coccyx. The tumor was cystic and fluctuant. There was no evidence of any other complication. At the operation the sac and nerve filaments were preserved.

and a fascial covering was approximated over the folded sac. The wound healed by primary union. No evidence of hydrocephalus was present before or after the operation. The boy has been followed for twenty-two months, is alert but continually soiling himself with urine in spite of efforts at regulation. He is inclined to be constipated. There is no paralysis or deformity of the extremities. The sixth case that survived the operation was a meningocele. This child was two and one-half years old when he was admitted to the hospital. He presented a soft fluctuant mass over the right sacro-iliac region the size of half of a lemon with a finger like projection of skin one and a half inches long. No nerve filaments were found at operation and the sac was excised and the defect in the bone covered by a fascial layer. The wound healed without the development of hydrocephalus. The child although she developed diphtheria in the hospital, survived and has been followed for seven months without any apparent disability or hydrocephalus.

Mortality.—The high mortality following the operation for this congenital anomaly can be attributed to the selection of cases which it is reasonable to suppose were doomed if not subjected to surgery (Tables X and XI). Not infrequently infants without any other disease seemed suitable for operation but died a few days after admission from some intercurrent disease or from

TABLE X
Cause of Death of Operated Cases

	Meningitis	Bronchopneumonia	Hydrocephalus	Shock
Cranial.....	1 meningocele 2 myelomeningoceles 1 myelomeningocele*		1 myelomeningocele*	2 myelomeningoceles
Cervical.....				
Dorsal.....				
Lumbar.....	1 meningocele	1 myelomeningocele	1 meningocele**	
Sacral.....	1 myelomeningocele 1 myelomeningocele*		1 myelomeningocele*	

** Erysipelas.

one of the many complications commonly associated with this condition. Some clinics have recorded a larger percentage of children that were operated upon with a smaller mortality. But it seemed to us that the forty-nine patients who died without operation would not have survived had they been subjected to surgery. An analysis of these cases revealed some complication

TABLE XI
Cause of Death of Cases Not Operated Upon

	Meningitis	Gastroenteritis	Bronchopneumonia	Hydrocephalus
Cranial.....	1 myelomeningocele	1 myelomeningocele*	1 myelomeningocele*	3 myelomeningoceles 1 myelomeningocele*
Cervical.....	1 myelomeningocele*			1 myelomeningocele* also lumbar myelomeningocele which ulcerated

TABLE XI *Continued*

	Meningitis	Gastroenteritis	Bronchopneumonia	Hydrocephalus
Dorsal.....	1 myelomeningocele 1 myelomeningocele* 1 myelomeningocele*		1 myelomeningocele*	1 myelomeningocele*
Lumbar.....	1 meningocele 15 myelomeningoceles 3 myelomeningoceles* 1 myelomeningocele*	1 myelomeningocele*	2 myelomeningocles 1 myelomeningocele*	6 myelomeningoceles 3 myelomeningoceles* 1 myelomeningocele*
Sacral.....	2 myelomeningoceles 2 myelomeningocles ^a		1 myelomeningocele	1 myelomeningocele 2 myelomeningoceles*

* Indicates the complications present in the same case at death.

to account for their early death which showed the futility of operation. The ultimate decision of whether or not to operate was generally the consensus of opinion of the visiting staff. The results that have been tabulated show that 67.7 per cent. of the thirty-seven patients that were operated upon survived and have been followed from two months to ten years; that the immediate operative mortality was 32.3 per cent. and that only 44 per cent. of the eighty-four cases that were admitted to the hospital were operable.

INDICATIONS AND CONTRA-INDICATIONS AND TIME TO OPERATE

Children with meningoceles presented the largest percentage of cases that were benefited by surgical intervention. If the dural protrusion was covered with normal skin and there was no evidence of hydrocephalus, the most favorable time to operate was as soon after birth as the general condition permitted.

In the absence of hydrocephalus and the presence of a sac that is thin and translucent, operation is advised before the sac perforates, ulcerates or becomes infected, thereby eliminating a potential infection and minimizing the chances of an ascending meningitis. It is generally assumed that amputation of the sac will precipitate an hydrocephalus. The likelihood of hydrocephalus developing after operation should not preclude surgery as hydrocephalus does not always follow surgical intervention. If the skin covering the sac is ulcerated, an attempt to dry the secretion should be made with a baking cradle. The protrusion should be protected from excoriation from pressure by placing the infant on its side with a pillow under its hip and bandaging the uppermost ankle to the side of the crib in the direction it faces, or by encircling the protrusion with a large cotton doughnut. Operation is contra-indicated if the skin is persistently ulcerated and infected, and in the presence of a progressive hydrocephalus and bulging dural sac.

The conditions governing operation for myelomeningocele are the same as for meningocele except for consideration of the various complications. The presence of slight congenital deformities of the extremities which are amenable to treatment should not be a deterring factor in children otherwise suitable for operation. Talipes equinus of one or both legs should not preclude operation as this condition is responsive to plastic tendon correction or the use of appliances. The presence of a paraplegia does not justify

operative interference, although Kolodny,⁵ advocated operation in their presence and reports favorably on the results. We have not been so fortunate. A girl ten years old, operated upon in another hospital soon after birth for a lumbar myelomeningocele with paraplegia, was admitted to the service in

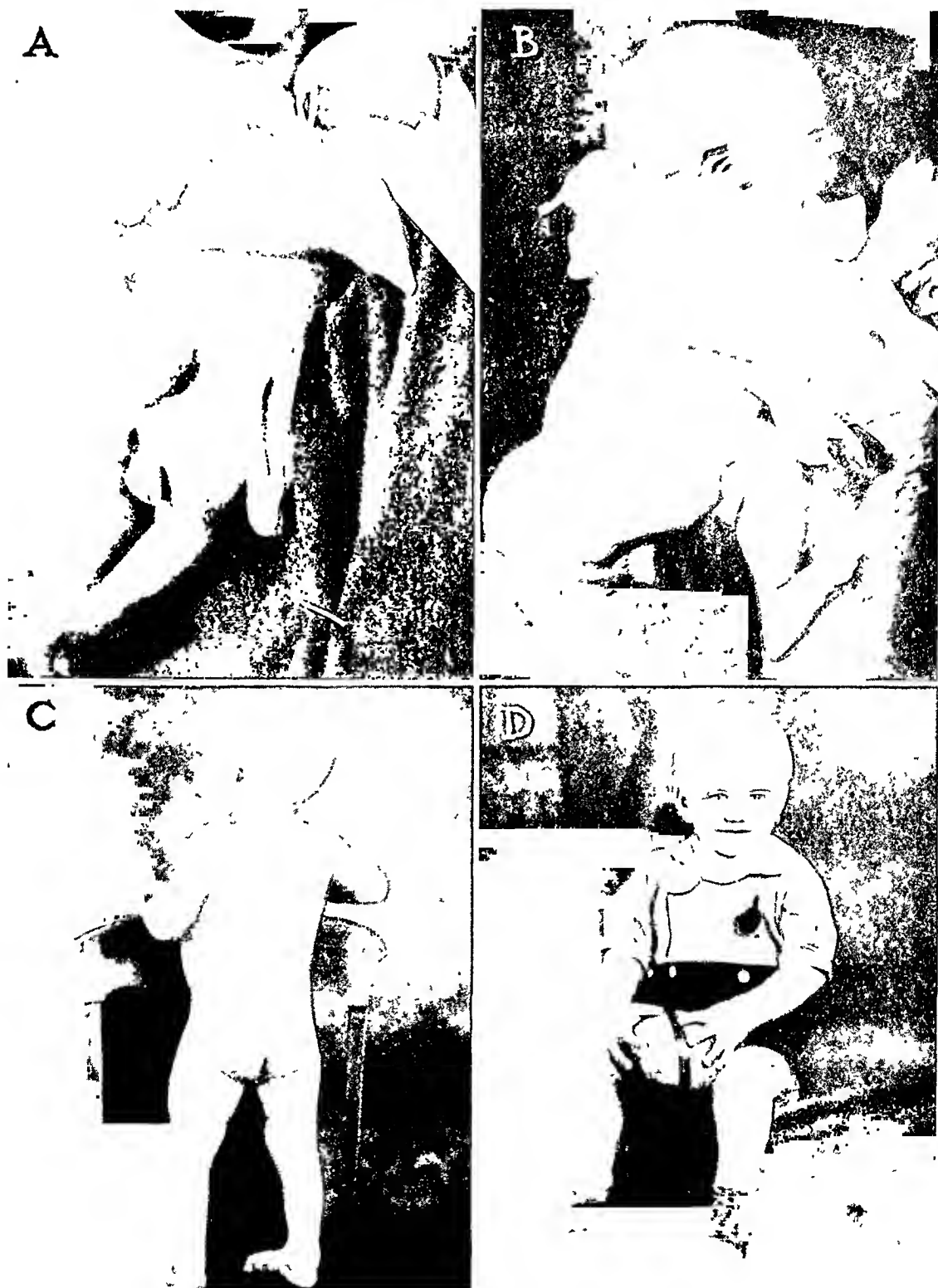


FIG. 5.—(Case V.) (A) Sacral myelomeningocele. Photograph taken when child was two weeks old, at which time he was operated upon. (B) Lateral view of the herniation. (C) Photograph taken twenty-two months after the operation, the sac is retracted. (D) Photograph showing the normal appearance of the head twenty-two months after the operation.

1933 with a fractured femur. She was mentally normal but suffered from bladder and rectal incontinence. The miserable existence since birth did not justify the prolongation of her life by operative intervention, as surgery did not improve her paralysis. The decision to operate on this type of case should rest entirely with the parents.

In no case did we effect a cure of vesical or rectal incontinence, but it was apparent that cases in which the sac was preserved were more readily responsive to training. The extent of vesical and rectal incontinence is difficult to determine in an infant. It becomes more manifest as the child grows older. Particularly is this to be observed in lumbar and sacral tumefactions. Constipation is more frequently observed than continuous expulsion of feces. If their faculties are not impaired they may cry or experience pain when the rectum is impacted.

The presence of a progressive hydrocephalus with a large or small myelomeningocele is a contra-indication to surgery. Removal of the dural sac and the repair of the defect will invariably be followed by an increase in the size of the existing hydrocephalus with an escape of cerebrospinal fluid or recurrence of the hernial protrusion. In one child the hydrocephalus increased after the operation and was followed by a recurrence of the hernial protrusion. Another operation resulted in recurrence and death. Occasionally hydrocephalus will not increase or else it will increase slowly and proportionately with the physical development of the child and then become arrested as equilibrium is established in the secretion and the absorption of cerebrospinal fluid. How great a compensatory factor the dura plays in each case cannot be determined until after attempting surgical correction. Our own observations in preserving the dural sac confirmed the conclusions of Penfield and Cone.³

In syringomyelocele surgery is not indicated. The extensive defect of the bony structure with eventration of cord and associated paralysis, deformities and advanced hydrocephalus are too much to relieve by surgical intervention.

Preoperative Treatment.—An infant who is amenable to surgery should continue on breast feedings. So many children die within the first month of life that general supportive measures should be exercised. The child should be kept on its side or on its abdomen and the tumefaction properly protected from pressure with a large cotton doughnut to prevent abrasions, ulceration and leakage of cerebrospinal fluid. Deferring operation will often prove fatal in selective cases which are suitable for repair. Gastro-intestinal disturbance has played an important rôle in undermining resistance and has often failed to respond to treatment. If the operation is deferred because of the condition of the skin covering the sacculation it should not be delayed too long beyond the period when the infant has regained the weight it lost since birth. The use of a baking tent will be found beneficial to dry the ulcerated skin, close a leaking sinus and help to maintain the body heat.

Treatment.—Aspiration of the fluid contents is strongly contra-indicated

as infection is very prone to develop. The injection of sclerosing solution is strongly to be condemned. It is generally assumed that surgery in selective cases is the only method that offers any hope of correction of this congenital anomaly.

The amputation of the sac as it emerges from the spinal or cranial defect has for many years been the accepted procedure. (Table XII.) Some

	Sac Amputated	Sac Preserved
Cranial.....	4 meningoceles 5 myelomeningoceles	
Cervical.....	2 meningoceles	
Dorsal.....	2 meningoceles	1 myelomeningocele
Lumbar.....	8 meningoceles 8 myelomeningoceles	1 myelomeningocele
Sacral.....	1 meningocele 2 myelomeningoceles	3 myelomeningoceles

surgeons have endeavored to dissect the nerve filaments from the dura and arachnoid and replace them and the brain contents into the bony defects. Penfield and Cone³ advocated the preservation of the sac to prevent the precipitation of acute hydrocephalus. They concluded from various experiments, "that the sac was an absorbing mechanism that cerebrospinal fluid might find its way out of the confines of the arachnoid through the protrusion, that hydrocephalus may be precipitated by the amputation of the protrusion and that plastic operation with the preservation of the sac is not complicated by such a sequel." In twenty-four of our thirty-seven children hydrocephalus was not in evidence before or after their operations. Hydrocephalus was not precipitated in four of the children with myelomeningoceles in whom the sac was preserved and there was a progressive increase in the size of the head for only about two months in a fifth case of myelomeningocele in whom the sac was not amputated. Inasmuch as acute hydrocephalus was not actually precipitated in any of the children in whom the sac was preserved this procedure should therefore be universally accepted. The preservation of the dura and arachnoid leaves a fullness over the bone defect which persists for a few months but gradually becomes less perceptible.

Preliminary Preparation.—The child should not be unnecessarily exposed on the operating table. The blankets should be warm and the child while lying on its abdomen should be placed in the Trendelenburg posture for closure of spinal defects and prone for cranial repair. This will minimize the unnecessary loss of cerebrospinal fluid. The extremities should be wrapped in cotton and held to the table with bandages. Picric acid solution in alcohol is used for sterilization of the skin and as few drapes as are compatible with safety are used to cover the patient.

The use of $\frac{1}{2}$ of 1 per cent. novocaine as a local anæsthetic is preferable to general anæsthesia. It allows the surgeon to make the necessary infiltration with a perfectly adequate margin of safety. It minimizes the likelihood of respiratory complications and has effectively served our purpose in most of the cases that have survived. Stronger solutions are warned against as infants may be subject to idiosyncrasies. This occurred in one case in which the operation had to be suspended to resuscitate an infant as a result of using a 1 per cent. solution.

Operation.—Longitudinal elliptical incisions are utilized through the healthy skin which is then undermined to the base of the sac. As much skin as the condition will permit is preserved to facilitate the closure. If the skin is ulcerated nothing is to be gained by protecting the ulcer with gauze as it only impedes the operation. Instruments should not be used for healthy structures if once brought in contact with questionable tissue. The skin is reflected and the neck of the sac is exposed. All adventitious tissue is excised or reflected so as to have a clear view of the projecting sac to determine its extent as it emerges from the bony defect. The sac, if not inadvertently opened, is incised at its uppermost portion using caution not to sever any nerve fibres. The cephalic end of the dura is least vascular and is most apt to be devoid of nerve filaments. The fluid contents of the sac are allowed to escape slowly. An attempt is made to replace the sac into the vertebral or cranial openings. If this procedure is not feasible the sac is then bundled over the defect and held with fine interrupted chronic sutures. The fascia on both sides of the defect is incised as far lateral from its bony attachment as will permit the fascia of one side to be reflected over the folded sac and be sutured to the base of the reflected fascia of the opposite side of the defect. The fascia of the opposite side is then made to overlap the first reflected fascial covering and is sutured to the attachment of the pedicle of the first reflected fascial layer. If the folded sac is bulky this may not be readily accomplished and the severed ends of the reflected fascial layers should then be approximated without imbrication. No bony or fascial transplant was attempted nor did it seem indicated. If the overlapping or approximating of the fascial layers would be insufficient to withstand the increased pressure of fluid that might be precipitated as a result of the operation, certainly the transplantation of a bone or the fascial graft would not withstand the increased fluid pressure, nor had we the assurance that such grafts would not slough in infants. The skin edges were approximated with fine silk. A piece of cotton covered with collodion was found adequate as a dressing.

Post-Operative Treatment.—The patient is returned to its crib and held in a prone position on its side by placing a small pillow under one hip and bandaging the uppermost ankle to the side of the crib. This position is maintained for several days. "Less sudden change in intracranial tension interferes with brain metabolism." (Von Bergmann.⁶) Body heat is maintained with a lamp from a baking cradle which is covered with a blanket allowing the head to be exposed. The position of the child should not be

changed any more than necessary. The fontanelles and the region of the operation is watched for signs of increased intracranial pressure. Should the wound become infected the dressings should be removed and the operative area should be left exposed to an electric light to aid in drying the wound. With the healing of the incision the head can gradually be elevated. We have not varied the normal requirements of fluid intake in infants for the majority are operated on so soon after birth. Proper nutrition is a valuable adjunct in their management since gastro-intestinal disturbances are not infrequently present. It is therefore desirable that the infant be fed on mother's milk if possible.

Complications.—The loss of an excessive amount of cerebrospinal fluid or blood at operation may prove fatal. Added to the trauma of the operation the shock resulting from these factors are contributing factors in the immediate cause of death.

Infection of the wound with the development of ascending infection and meningitis was responsible for the loss of seven children. The development of acute hydrocephalus was the contributing cause of death in three cases. Gastro-intestinal infection and marasmus played no small factor in undermining the resistance of two children.

Rectal and bladder incontinence proved troublesome in the subsequent management of cases of myelomeningoceles particularly in the lumbar and sacral spina bifidæ in which there had been a prolapse of the nerve elements. The rectal sphincter paralysis frequently manifested itself by extreme constipation and a feeling of fullness which in the very young would be indicated by weeping. As the child grew older constipation would become more obstinate and would require frequent enemas and strong laxatives. This disturbance was less embarrassing than the vesical incontinence which gave the child no warning. Older children by training to void every two or three hours would in some cases prevent wetting themselves. The Coffey procedure for transplantation of the ureters has been suggested for relief in persistent cases in older children, to whom no sensation with habit formation can be developed. Delbet and Leri,⁷ and Dalziel,⁸ and Leopold,⁹ reported surgical cures of urinary incontinence in cases of spina bifida occulta. We have been unable to find a case of myelomeningocele in which incontinence has been cured by operation.

Operation has not benefited children with paralysis of extremities in any of our cases and rarely has operation benefited any case reported in the literature except those reported by Kolodny.⁵ Recurrence of the hernial protrusion took place in two children due to increased cerebrospinal fluid pressure and advancing hydrocephalus. A slight bulge may be perceptible and palpable over the operative area which will require no treatment. This becomes less appreciable with advancing years, particularly so in sacral meningoceles.

Parents should be warned against careless exposure to heat, particularly hot-water bottles. A child, who was operated on for a sacral meningomyelo-

cele at the age of four years, burned her buttock below the operative incision when she was seven years old. It required many months of care before the area responded to treatment.

SUMMARY AND CONCLUSIONS

An analysis is recorded of eighty-four cases of spina bifida; forty-seven (56 per cent.) were not operated upon while thirty-seven (44 per cent.) were subjected to operation. Of those not operated upon all but one had died within twenty-four hours to one year after admission to the hospital. Of the thirty-seven patients operated upon there was a hospital mortality of 32.3 per cent. and the 67.7 per cent. which survived the operation have been followed for periods from two months to ten years.

In determining the cases that are suitable for surgical intervention and upon which successful results are dependent it is of the utmost importance to consider the following: First, the condition of the coverings of the protrusion. Second, the contents of the dura and the extent of involvement of the nerve, cord and brain tissue if present. Third, the extent of the defect in the bony structure. Fourth, the degree of hydrocephalus and other congenital deformities and anomalies.

The prognosis in infants who are suitable for operation is best when the operation is performed as soon after birth as the general condition permits, before unavoidable pressure produces ulceration and impending rupture, with leakage of cerebrospinal fluid and ascending meningitis, marasmus or some intercurrent disease to which they are susceptible.

The possibility that hydrocephalus may follow operative correction of a spina bifida should not cause one to defer intervention in a suitable case. Of the thirty-two children whose sacs were amputated, hydrocephalus increased in seven of the eight children in whom it was previously present and it was precipitated in but four of the children in whom there was no previous evidence of hydrocephalus. Hydrocephalus was not increased in a child in whom the sac was preserved nor was it precipitated in four other children in whom the dura and arachnoid were retained. The preservation of the dural sac as advocated by Penfield and Cone³ is recommended as the operative procedure of choice.

The presence of a spinal or occipital herniation which is thin, tense and then ruptures and alternately closes and ulcerates with a discharge of cerebrospinal fluid, complicated by a slowly progressive hydrocephalus, does not in all cases contra-indicate surgical intervention as the results of some of the operations are very gratifying.

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BRIEF COMMUNICATIONS AND CASE REPORTS

CARCINOMA OF THE RIGHT LUNG*

PNEUMECTOMY IN ONE STAGE

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CASE REPORT

Mrs. C., aged 61, was referred by Dr. R. Conklin to the Medical Clinic of St. Luke's Hospital, service of Dr. L. Frissell, with the following history: Eight years previously a Wertheim radical hysterectomy for epithelioma of the cervix had been performed by the author. Until one year before admission she remained entirely well, then she caught a cold which, though mild, persisted for weeks. A roentgenogram of the chest showed a typical bronchogenetic carcinoma of the right upper lobe. Subsequent roentgenograms showed a considerable enlargement and extension of the lesion (Fig. 1.).

One week before entering the clinic she was seized with a sharp pain in the upper portion of the right chest, accompanied by a dry, hacking cough. The cough was relieved but the pain persisted and gradually spread to the back and to the right shoulder, accompanied by loss of weight and strength. Bronchoscopic examination by Doctor Hart revealed no pathology.

A diagnosis of primary carcinoma of the right lung was made. An artificial pneumothorax was induced and maintained until a satisfactory collapse with stabilization was obtained. A few days before operation, 450 cc. of air were introduced, the initial pressure being $-8 -0$, the final pressure $-2 +4$.

Operation.—February 20, 1935. One stage pneumectomy for primary carcinoma of the right lung. Time: Two hours.

Operator: Doctor Lyle. Assistant: Doctor Ada.

Pathologic Findings.—On opening the parietal pleura in the third right intercostal space, the lung was found to be adherent to the anterior chest wall. Further exploration showed that practically the upper half of the right lung was adherent to the parietal pleura down to the level of the fourth interspace. There was a rounded, stony hard, grayish tumor occupying the upper half of the right lobe. It had apparently invaded the parietal pleura and the endothoracic fascia attached to the third rib anteriorly. The attachment of the tumor to the parietal pleura would cover an area the size of a 50 cent piece. The apex was firmly adherent but the lower half of the lung was entirely free and collapsed, the thoracic space being occupied by air from the previous artificial pneumothorax. The lymph nodes at the hilus of the lung were enlarged and hard. There was no evidence of extension into the mediastinum. During the ligation of the vessel of the hilus of the lung, an encysted area of yellowish pleural exudate was encountered in the vertebral gutter.

Operative Procedure.—Anesthesia: Colonic oil-ether, plus positive pressure with nitrous oxide gas. Position: The patient was placed on the left side, the right arm raised above the head and the body elevated to an angle of 45 degrees. Rienhoff's anterolateral incision was made in the third right intercostal space. The incision extended from the

* Presented before the New York Surgical Society, April 24, 1935.

border of the sternum to the midaxillary line and was deepened through skin, breast, pectoral and costal muscles until the bulging pleura was exposed. The thoracic cavity was then entered just below the lower portion of the tumor and in the area of the adherent pleura. The outlying fine adhesions were readily freed. As the tumor proved to be adherent to the overlying structures, it was decided to excise the third rib. The third costal cartilage was divided at its sternal extremity and the third rib, along with the second intercostal muscles and underlying pleura, was removed. The pleura over the dome of the right thorax was stripped off posteriorly to the level of the third rib and removed. A Lilienthal rib retractor was inserted and an excellent exposure of the root of the right lung was obtained.

The lung was separated from the mediastinum over an area of three inches, and

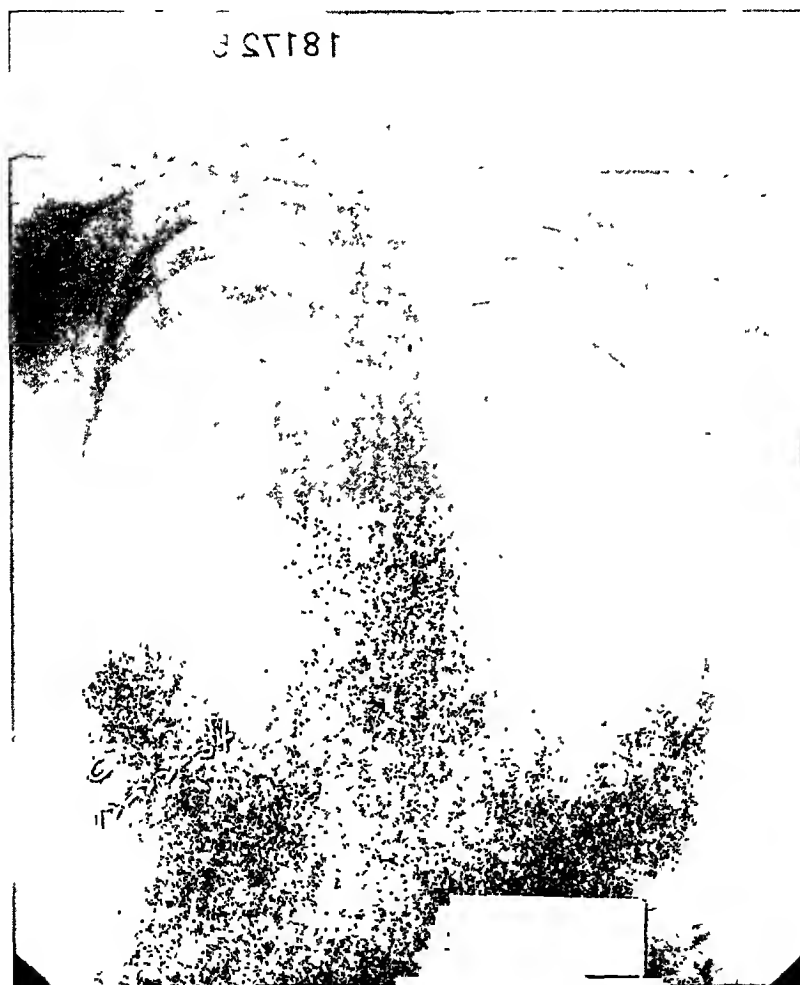


FIG. 1.—Roentgenogram taken December 12, 1934, showing the lesion in the right upper lobe.

two large pulmonary veins entering the hilus of the right lung were exposed, isolated and divided between silk ligatures. The pulmonary artery which lay in front and below the right primary bronchus was exposed, isolated and divided between silk ligatures. A thorough exposure was made of the right primary bronchus with its eparterial and hyparterial branches. A No. 5 braided silk suture was passed around the right primary bronchus and tied, completely closing the bronchus. A heavy clamp was applied to the main bronchus at the division into its two branches and the main bronchus severed between the clamp and the central ligature. This freed the hilus of the lung. The lung was then retracted medially and the parietal pleura divided at its reflection from the posterior thoracic wall. In this way an excellent exposure of the pulmonary ligament was obtained. The ligament was grasped between the fingers and divided. In its

division an unrecognized pulmonary vein was cut. It was promptly clamped with a loss of a very small amount of blood. The lung with peribronchial nodes was removed from the thorax. The cut end of the right bronchus was reinforced with interrupted silk mattress sutures. The incision in the thorax was closed in layers by interrupted mattress sutures with the object of making an air tight closure. This was difficult on account of the excision of the third rib, pleura, and intercostal muscles.

The patient stood the operation exceedingly well. There was no evidence of shock. Throughout the operation there was practically no loss of blood. At its conclusion



FIG. 2.—Photograph of the right lung showing the carcinoma in the upper lobe.

the patient was given a transfusion of 500 cc. of whole blood and was returned to the ward in good condition.

Pathological Report by Dr. L. C. Knox: Diagnosis: Carcinoma of lung, right upper lobe. Peribronchial nodes involved.

Macroscopic Examination.—Specimen consists of entire right lung, measuring 22 by 14 by 1 to 5 cm. Occupying the upper lobe is a very firm, friable, irregularly rounded tumor mass 6.5 by 4 by 7 cm. in diameter, situated 0.5 cm. from the medial surface and 0.5 to 1 cm. from the posterior surface of the lobe (Fig. 2). Anteriorly the tumor has been adherent to the thoracic wall and the overlying rib. The pleura in this region is thickened, adherent and infiltrated. On section the growth has a whitish yellow cellular cut surface which is mottled with anthracotic pigment and gives evidence of some necrotic change. The middle lobe is poorly delimited; however, in its upper

anterolateral portion bordering on the anterior extremity of the transverse fissure is a small, superficial metastatic nodule measuring 1 by 1 by 0.5 cm. No other such nodules are found on section of the rest of the lung tissue which exhibits a uniform loss of aeration with a prominent bronchial tree. The remaining visceral pleural surface shows several scattered thin fibrous adhesions, most marked anteriorly. A portion of the rib included with the specimen reveals infiltration of the parietal pleura with tumor growth. The growth has been adherent to the chest wall in this region. A separate discreet nodule of tumor is attached close to the adherent area underlying the rib and measures 1.5 by 0.5 by 1 cm. Grossly it is difficult to determine how deeply the growth invades the thoracic wall. The hilar nodes are firm and appear infiltrated macroscopically.

Microscopic Examination.—Sections of the tumor from the margins of the mass show the center of it to be almost entirely necrotic, but at the periphery there is a zone of cellular tissue composed of large epithelial cells replacing almost all the normal struc-



FIG. 3.—Roentgenogram taken 12 days after operation, showing the right thoracic space filling with serosanguineous fluid.



FIG. 4.—Roentgenogram taken 17 days after operation.

ture, filling the acini, and obliterating the architecture of the lung. These cells are extremely large, but very irregular. There are many degenerative changes with clear cytoplasm as well as very granular cells, possibly fatty. There are, however, many mitotic figures throughout. There is slight differentiation and a little palisading, although no intercellular bridges which can be certainly identified. The tumor, however, has the appearance of having arisen from the squamous epithelium and is of the morphologic group which forms the largest number of pulmonary tumors. It is impossible to state that morphologically it does not resemble an epithelioma from the cervix, but since such tumors metastasize very rarely and since this type is most commonly found in the lung, it would appear that the growth is primary in that region.

The nodes from the hilus of the lung adjacent to the bronchi show extensive fibrosis, necrosis, large masses of anthracotic pigment, and besides this an infiltration with tumor cells. Many of these are enclosed within dense fibrotic capsules. These nodes are adjacent to the cartilage of the lung, but neither the cartilage nor the mucous membrane is involved in the section. The morphology of the tumor is similar through-

out the sections. The growth extends nearly to the bone, which, however, is not involved in these sections.

Postoperative Course.—The first day after operation, the patient complained of dysphagia and severe pain in the right diaphragm. Respiration 28, pulse 100, temperature 99.3°, blood pressure 118/76. The left lung was well aerated and no râles were heard. The heart was slightly displaced to the left, but there was no cyanosis at any time. As a precautionary measure, the patient was placed in an oxygen tent for two days.

Roentgenograms taken the latter part of the first week showed a gradual accumulation of fluid. These findings were confirmed by the aspiration of a moderate amount of bloody fluid. Eight days after operation the patient was comfortable, having no dyspnea and the dysphagia had diminished.

Roentgenograms on the thirteenth day (Fig. 3) revealed that the right chest was filling with fluid. On the afternoon of the same day there was serosanguineous discharge from the wound. Later 160 cc. of bloody fluid were aspirated. A small bronchial leak was discovered on the fifteenth day (Fig. 4). Intermittent suction drainage was established in the fifth space posteriorly on the seventeenth day.

On the nineteenth day, in the course of aspiration with a negative pressure water aspirator, the apparatus was incorrectly connected and ordinary cold tap water was delivered into the right chest cavity by mistake. The error was not discovered until the cavity became distended. The controls were then reversed and aspiration established. The accident caused considerable reaction. The temperature, which had been normal from the end of the first week, rose to 103.6°, the pulse to 112, respirations 32. The result was an empyema for which a posterior drainage had to be done. Culture of the pus showed *Staphylococcus albus hemolyticus*.

Despite the setback, the patient made a good recovery. Sixty-two days after operation, she walked eight city blocks with very little respiratory embarrassment. A small draining sinus still persists. Whether she will have to have the empyema cavity collapsed remains to be seen. At present the indication is that it will not be necessary.

A search of the literature reveals the fact that there have been very few successful one stage pneumectomies for carcinoma of the lung,¹ and that right pneumectomies are more infrequent than left, according to Overholt,² who performed the first successful right pneumectomy.

In conclusion it may be stated that we employed the technic described by Rienhoff.³ His anterolateral incision in the third interspace gave us a splendid exposure of the hilus of the lung.

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DISCUSSION.—DR. CARL EGGERS (New York) stated that successful resection of a lobe or of an entire lung for carcinoma is still sufficiently infrequent that each case deserves presentation and consideration not alone from the standpoint of diagnosis, but also of treatment. Much of the knowledge acquired in the past about malignant tumors of the lungs has had to be revised in the light of recent advancement on the basis of successful resections.

A patient with lobectomy for carcinoma presented by Doctor Eggers before the New York Surgical Society last year had been under observation for six months in different hospitals and by different physicians, and in whom repeated roentgen examinations, bronchoscopy and examination of the pleuritic exudate had failed to make a positive diagnosis. She was finally operated on six months after onset with a clinical diagnosis of cancer. A case like that shows how important it is to stress diagnosis, early diagnosis being essential to progress in surgery of the lungs, that is, diagnosis before the primary tumor has extended to involve surrounding vital organs, and before metastases have spread in the pleura or into the mediastinum. Even with an early diagnosis, however, not all lung tumors are suitable for operation. If a malignant growth involves the main bronchus close to the bifurcation, a safe closure is unlikely. If it involves the parenchyma close to the pleura it may have invaded the latter and spread metastases throughout the pleural cavity. A pleuritic exudate in a patient with suspected carcinoma of the lung is very suspicious. The most ideal case and in whom one may reasonably expect a good result is one with a single tumor at some distance from the main division of the bronchus and not too close to the pleura. In view of the difficulties connected with the diagnosis and treatment of these cases, the increased frequency with which lobectomies and pneumectomies are being reported is gratifying.

It is essential, of course, Doctor Eggers emphasized, to evaluate early symptoms. For a long time, there may be only cough—often dry and harassing, at other times productive and frequently blood stained. It is at this time that diagnosis should be made. When pain, dyspnea and pleuritic exudate are added, it may be too late. An early roentgenogram may determine the diagnosis. However, a tumor may simulate a chronic inflammatory lesion so that roentgen diagnosis is impossible, roentgenologists, like clinicians and surgeons, having a great deal to learn about the diagnosis of tumors. In any suspicious case, if the roentgen examination fails to clear up the diagnosis, a bronchoscopy should be done, with possibly a biopsy and bronchography. A pneumothorax may be done. A pleuritic exudate may be examined for tumor cells.

Even after a diagnosis has been made, there are many points to be considered. The approach to the lesion is important, that is, whether to go in anteriorly or posteriorly. The former may be easier in certain cases, but in the event of extensive adhesions a wide posterior approach might be better. The care of the stump is tremendously important, as is, also, the question of drainage.

DR. GEORGE J. HEUER (New York) knew of only six cases of successful total pneumectomy for carcinoma of the lung besides that of Doctor Lyle. Partial operations, such as resection, lobectomy, *etc.*, have not yielded very brilliant results. Since 1920 there have been 33 resections or lobectomies with a primary mortality of 39 per cent. Of the 20 patients who survived operation, 14 died or were living less than one year, one was living two years, two were living more than two years, and two were considered cured. Although this is a great advance over what obtained in this disease previously, it is hoped that earlier diagnosis with total pneumectomy will further improve the results. In spite of having personally explored a number of cases of carcinoma of the lung, Doctor Heuer said that he had not yet been fortunate enough to see a case in which total pneumectomy was feasible. There had been implantations in the mediastinum, upon the pericardium, and so forth, which made total pneumectomy unwise, even though it was technically possible.

TOTAL REMOVAL OF THE LEFT LUNG FOR CARCINOMA*

JOHN B. FLICK, M.D. AND JOHN H. GIBBON, JR., M.D.

PHILADELPHIA, PA.

CASE REPORT

R. S., a white male, aged 46, entered the Pennsylvania Hospital April 9, 1934, complaining of pain in the left side of the chest. He had a common cold in December, 1933, following which he had a persistent cough, expectoration of thick yellow sputum, and night sweats. These symptoms were accompanied by a dull pain in the left supraclavicular region, left shoulder and left upper chest. Coughing increased the pain. Shortness of breath on exertion became apparent shortly after the onset. He had lost 12 pounds since the onset of his symptoms. He had had no previous serious illnesses and there was no history of tuberculosis or cancer in his family.

On examination the patient did not appear ill. There was definite limitation of expansion and dullness on percussion over the left upper chest anteriorly. Vocal fremitus and vocal resonance were much diminished and breath sounds could scarcely be heard over this area. There were no other abnormal findings in the lungs. The heart was of normal size, and there were no cardiac murmurs. There was slight clubbing of the fingers, but no cyanosis. The blood pressure was 120/80. The blood Wassermann was negative. The hemoglobin was 83 per cent, and the red blood cells 3,300,000. The temperature and pulse rate were normal during two days' observation in the hospital.

A diagnosis of an obstructing lesion of the left upper lobe bronchus was made by Dr. P. A. Bishop on roentgenologic examination (Fig. 1). The left upper lobe was atelectatic. The trachea, superior mediastinum and aorta were displaced to the left and the left upper lobe showed compensatory emphysema. A shadow in the hilum region extending out into the upper lobe suggested an infiltrating lesion, probably bronchial carcinoma. Because of the marked displacement to the left of the trachea and the left main bronchus, it was impossible to visualize the orifice of the left upper lobe bronchus through the bronchoscope. Surgical exploration of the chest was advised, but the patient decided to leave the hospital and consider the question of operation later.

He was readmitted June 4, 1934. During the interval his cough had become worse and small amounts of blood appeared in the sputum every day. Dyspnea had increased and at times he had an asthmatic wheeze. The physical signs had not changed appreciably since the first admission. The vital capacity was 1,600 cc. June 5, 400 cc. of air were introduced into the left pleural cavity through the seventh interspace in the posterior axillary line. June 8, an additional 500 cc. of air were introduced, following which the intrapleural pressure became positive. After the pneumothorax had been produced roentgenologic examination showed slight compression of both upper and lower lobes and evidence of pleural adhesions.

A left total pneumonectomy was performed (by J. B. F.) June 13, 1934. The patient was anesthetized with tribromethanol (60 mg. per Kg. of body weight) supplemented by nitrous oxide. An incision was made from the sternum at the level of the third costal cartilage, curving downwards and outwards beneath the nipple to the posterior axillary line. The skin and subcutaneous tissues above the incision were reflected upwards and the pectoralis major and minor muscles were divided at the level of the fourth rib. The tissues in the third interspace were incised and the pleural cavity opened. The third costal cartilage was divided from within the chest, allowing greater separation of the third and fourth ribs. Firm adhesions were encountered at once. The fissure between the lobes was obliterated. The separation of adhesions was accomplished by blunt dissection and was tedious and time consuming. A hard mass about 10 cm. in diameter could be felt in the upper lobe close to the hilum. This was firmly adherent

* Read before the joint meeting of the Boston Surgical Society and the Philadelphia Academy of Surgery in Philadelphia, February 4, 1935.

to the pericardium over an area of several square centimeters. Rather than attempt the separation in this region, the pericardium was opened and the adherent portion excised, leaving it attached to the tumor. Two large mediastinal lymph nodes were removed, and carcinoma was reported on examination of the frozen sections from one of them. The lung was densely adherent along the spinal gutter and in the region of the arch of the aorta, and was separated with difficulty. Adhesions to the diaphragm were not disturbed at this time. In separating the upper lobe from the anterolateral aspect of the chest wall, thick yellow odorless pus was encountered. This was aspirated and a pack introduced. After freeing the region of the hilum, a ligature was placed around

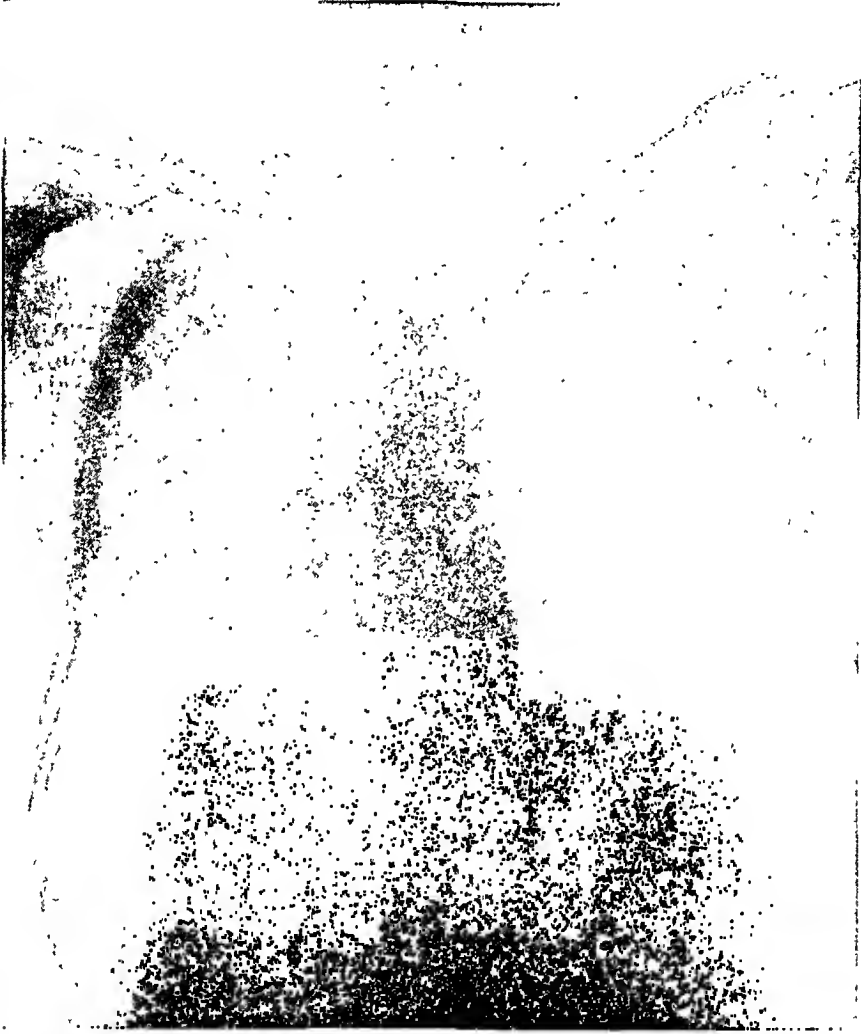


FIG. 1.—Roentgenogram made of the patient's chest three weeks prior to operation.

the pulmonary artery and tied. Clamps were placed on the pulmonary veins and the main bronchus and these structures divided. Adhesions to the diaphragm were then freed and the lung removed. While tying a ligature about one of the pulmonary veins, the gut broke and there was free bleeding for some seconds. The vessel was again clamped and tied. All blood vessels were ligated with No. 2 chromic gut. The clamp was removed from the bronchus and phenol was applied to the mucous membrane. The edges of the bronchus were caught with two sharp hooks and three mattress sutures of No. 00 chromic gut (using the type of sutures with needles affixed) were placed close to the cut end of the bronchus. The closure was reinforced with a continuous suture of the same type of gut. A piece of fatty tissue from the mediastinum was tied over the suture line. When the bronchial stump was released, it retracted almost out of sight into the mediastinal tissues. Two additional large soft lymph nodes were removed

from over the arch of the aorta and one from the mediastinum. The defect in the pericardium, through which the left auricular appendage prolapsed, was not closed. The

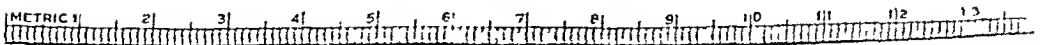


FIG. 2.—Photograph of the specimen removed at operation which has been sectioned to show the growth.

pleural cavity was quite dry at the end of the operation. Intrapulmonary pressure was raised to 8 Mm. of mercury without evidence of any air leaking from the bronchial

stump. The wound was closed anatomically with interrupted sutures of chromic gut. Two pericostal sutures were placed about the third and fourth ribs. The skin was closed with silk. Shortly after removal of the lung, the patient's systolic blood pressure dropped to 70 Mm. of mercury. An intravenous infusion of 5 per cent glucose in normal saline was begun and continued until the operation was completed. The patient was then given 500 cc. of blood and placed in an oxygen tent.

A summary of the pathologic report follows: The fresh specimen (Fig. 2) consists of a left lung intact and several lymph nodes. The nodes range from 1½ cm. to 3 cm. in maximum diameter. The largest shows an extensive whitish infiltration suggestive of tumor. The smaller ones appear normal except for anthracotic coloring. Externally the upper lobe is firm and the lower lobe partially collapsed. There are extensive adhesions over the visceral pleura and at the apex there appears to be a patch of thickened parietal pleura attached to the lung. The two lobes are firmly adherent to each other throughout the course of the interlobar fissure. On section of the lung an irregular tumor mass 6 cm. in greatest diameter is seen medial to the midpoint of the upper lobe. This is yellowish white and firm. The border is slightly lobulated. Near the center of the mass remnants of a main branch bronchus can be seen in the shape of crescents of cartilage embedded within the tumor. Traced toward the hilum, extension of the tumor along the bronchus is evident with elevation of the mucosa. Lung tissue and vessels are compressed, and at one point a branch of the pulmonary artery is invaded by the tumor. The upper lobe distal to the tumor mass shows multiple large bronchiectatic cavities, up to 1 cm. in diameter, with smooth thick walls. The interlobar septum is 1 to 2 Mm. thick. The cut surface of the lower lobe shows no evidence of tumor.

Microscopically, the tumor cells have pale oval nuclei with a few chromatin granules and a well defined nuclear membrane. A squamous cell type is strongly suggested. There are moderate numbers of hyperchromatic nuclei and mitotic figures. Many of the tumor islands have necrotic centers. The advancing border is irregular and the appearance is one of rather rapid growth. Extension along a large bronchus with invasion of its wall is well shown. A round cell and fibrous infiltration surrounds the bronchiectatic cavities whose lining epithelium is in most cases well preserved. The same interstitial changes are seen in the more distant portions of the upper lobe. Here the alveolar septa tend to be better preserved and the alveoli are frequently occupied by numerous polygonal phagocytic cells, containing pale brownish granules. Areas of actual pneumonia are not seen. The interlobar septum is thickened by vascular, partially hyalinized, fibrous tissue rather heavily infiltrated by round cells, but not invaded by tumor cells. Round cell infiltration is intense in the portion of the upper lobe bordering on this septum. The cavities in the lower portion of the upper lobe are more poorly defined and contain cellular débris. The lower lobe is the seat of vascular congestion, moderately advanced patchy atelectasis and frequent small collections of heart failure cells, but apparently has escaped malignant invasion. Metastatic growth in lymph nodes resemble the primary tumor except for a greater tendency to necrosis. Pneumococcus, Type 3, was cultured from the pus of the loculated empyema encountered at operation.

A diagnosis was made of carcinoma of the left upper lobe with metastasis to the regional lymph nodes, and bronchiectasis of the left upper lobe secondary to bronchial obstruction by the tumor.

The patient's voice was hoarse immediately after the operation. The oxygen tent was used for several days. Serosanguineous fluid was aspirated from the chest on the second postoperative day. Pneumococcus and *Staphylococcus albus hemolyticus* were cultured from the fluid. The fluid gradually became purulent on repeated aspirations. One week after operation closed drainage was instituted through a No. 22 French catheter in the fifth interspace in the posterior axillary line. The sutures were removed on the ninth day. Two days later the patient coughed and expectorated some

reddish pus. This did not recur and was the only evidence of a bronchial fistula that was observed. A small opening at the medial end of the incision was also noted on the same day.

Because of the persistence of irregular fever and pain from pressure of the catheter between the ribs, open drainage was performed one month after operation under local anesthesia. Small portions of the fourth and fifth ribs were removed and tubes inserted. Because the drainage was blood tinged and the pain persisted, the old operative wound was opened five days later under avertin anesthesia. The third rib at the sternal end had separated from the cartilage and obviously was infected. It was removed as far back as the midaxillary line. An additional portion of the sternal end of the fourth rib also was excised. The chest cavity was explored. The diaphragm reached the level of the fourth rib and the mediastinal structures had shifted somewhat to the left. No trace of the bronchus could be found. The outline of the arch of the aorta could be seen. The cavity was lined with granulations, and in several areas catgut ligatures could be seen, about which there were depressions in the granulation tissue and a little pus. The bloody pus apparently came from the granulation tissue surrounding the necrotic third rib. The cavity was packed with 1 to 1,000 acriflavine gauze.

The infection cleared up rapidly following the operation, and the empyema cavity gradually diminished in size. August 17, about two months after the pneumonectomy, an upper posterior paravertebral thoracoplasty was performed to hasten the obliteration of the cavity. The fourth, fifth and sixth ribs were removed from the transverse processes to the point of previous section. In addition 7.5 cm. of the first, 11.5 cm. of the second, 14 cm. of the third, and 10 cm. of the seventh ribs were resected. The wound was closed without drainage.

The cavity was greatly diminished in size by the operation, and 11 days after operation the patient was allowed out of bed in a chair. Activity was gradually increased, and by the middle of September, three months after the pneumonectomy, the patient was up and about the greater part of the time. Roentgen ray therapy was begun at this time. One month later, on October 15, the posterior wound was opened and a small pocket of pus drained. At the same time a piece of necrotic third rib cartilage was removed.

In November a small tender swelling appeared in the eleventh interspace 7 cm. from the midline posteriorly. The roentgenogram showed some destruction of the lower border of the eleventh rib and the upper border of the twelfth rib in this region. Under local anesthesia the nodule was exposed and found to be neoplastic. A biopsy was done and a 50 mg. capsule of radium introduced. The capsule was removed 28 hours later. The tissue removed was metastatic carcinoma. The nodule diminished rapidly in size after the radiation and the patient was removed to a convalescent home in December. He still had small draining sinuses in both anterior and posterior wounds and some cough and expectoration.

He returned to the hospital in January, 1935, for roentgenologic examination and bronchoscopy. His condition had not improved since leaving the hospital. No new lesions were found roentgenographically. Ulceration of the blind end of the left main bronchus was seen through the bronchoscope and thought to be due to a recurrence of the growth.

NOTE.—The patient's condition became steadily worse in the hospital and he died February 27 from hemorrhage from the anterior chest wound. Autopsy showed a local recurrence of the growth about the left bronchial stump and the adjacent lymph nodes were involved. A portion of the recurrent growth had become necrotic, forming an abscess in the posterior portion of the remaining pleural cavity. The abscess communicated with the lumen of the left bronchus by a small sinus tract. The hemorrhage occurred from erosion of a blood vessel. Aside from this local recurrence and the nodule in the left eleventh interspace there was no other evidence of tumor. The right lung and its tributary lymph nodes were not invaded by the growth.

MEDIASTINOTOMY FOR SUBSTERNAL GOITER*

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ENLARGEMENT or prolongation of the thyroid gland behind the sternum in the thoracic cavity are interchangeably called substernal or intrathoracic, though the latter is more commonly applied when the greater portion or a considerable amount of the gland lies in the superior mediastinum. It is not at all uncommon for goiters to be partially substernal. The pathology is almost always an adenoma or a malignant neoplasm, rather than Graves¹ disease. An adenoma located in the lower pole of a thyroid lobe grows by following the path of least resistance into the superior mediastinum.

The more snugly the tumor is wedged in the superior thoracic aperture, the more pronounced are the symptoms, most often due to tracheal compression. These patients have varying degrees of dyspnea, with inspiratory stridor, choking and coughing spells, the next commonest symptoms being dilated neck veins, laryngeal cord paralysis, and dysphagia.

At operation the usual collar incision is made and the ribbon muscles divided. The superior thyroid arteries are divided and ligated and likewise the middle thyroid veins. Next, the isthmus is split and the lobes freed from the trachea, from above downward. In most substernal goiters, the inferior thyroid artery which enters the gland near the middle of the lobe remains in the neck and may be divided before the substernal portion is attacked. Fortunately, all the blood supply of an intrathoracic goiter descends from above downward with the descent of the goiter. Attempts to pull the tumor out by hooks and clamps usually result in tearing of the gland and bleeding. The most certain way is to insert a finger into the mediastinum, sweep the finger about the tumor to free it from its enveloping connective tissue and pry the growth out by pressure from below upward. This finger is more safely passed behind than in front as there are no veins posteriorly to be torn. Rarely, the size of the intrathoracic tumor makes it necessary to split the sternum.

CASE REPORT

A colored woman, 50 years old, had had since puberty a small lump in her thyroid gland. For five years there had been progressive enlargement of the gland with increased difficulty in breathing. For two years there were shortness of breath, swelling of the ankles, and other symptoms and signs indicating impaired heart function. For two months she had had severe attacks of dyspnea, worse at night, feeling at times as though she were choking to death.

Physical examination revealed a large adenomatous goiter, extending on the left to the trapezius and on the right to the sternocleidomastoid muscle. There was marked dulness over the sternum. Roentgenologic examination revealed a mass extending from the cervical area into the mediastinum well below the level of the aortic arch. The mass measured at a maximum four and one-half inches in diameter extending to right and left of the midline, though more prominent on the left and resulting in marked tracheal

* Read before the New York Surgical Society, March 27, 1935.

compression and deviation to the right; the esophageal lumen was also compressed and displaced.

Operation was advised but was declined until increasing dyspnea and the fear of choking to death led the patient to accept surgical intervention. She was considered a poor surgical risk due to her myocarditis.

Operation.—August 30, 1934, under ethylene anesthesia, the superior pole and the lateral masses were easily freed and the blood vessels ligated, leaving a small portion of the upper right lobe. It was impossible to insert a finger into the thoracic aperture, either from behind or from in front of the mass. There were numerous veins, some of them the size of one's little finger. Traction on the intrathoracic mass was of no avail. The fear of hemorrhage and the strong possibility of malignant changes in the tumor contraindicated morcellation and led to the adoption of the method used by Lilienthal who in 1915 split the sternum to remove an intrathoracic goiter. Accordingly, the manubrium and sternum were split in the midline downward for six inches with a chisel, whereupon, after retraction of the separated sternum, the mass was easily delivered without hemorrhage and with no respiratory embarrassment. The aorta and heart were readily visualized and a large pad inserted into the mediastinum. Ten minutes after removal of the mediastinal tumor and during the process of suturing the wound, the pulse stopped abruptly and the patient ceased to breathe, efforts to resuscitate were of no avail. Up to this time the pulse had not gone above 96 per minute and there was never any interference with respiration. While no autopsy was permitted, death was probably due to embolism, there being no evidence of pulmonary collapse.

The pathologist reported the tumor to weigh 338 Gm., a trilobed mass, each lobe measuring 140 by 90 by 60 Mm. and 90 by 55 by 30 Mm. and an isthmus connecting these two lobes measured 55 by 45 by 30 Mm. The tumor was a highly malignant adenocarcinoma, partly solid in type, with extensive necrosis and cyst formation, suggesting origin in fetal adenomata.

This case is of interest because the large size of the intrathoracic goiter necessitated splitting the sternum, a method rarely necessary and reserved only for the large and difficult intrathoracic goiters. The failure of the patient to survive should not condemn the method but should serve as an argument for early operation upon all goiters tending to become substernal, before advancing age with increasingly poor physical condition and the necessity of a more difficult and hazardous operation make the prognosis worse.

TOTAL THYROIDECTOMY FOR CONGESTIVE HEART FAILURE AND ANGINA PECTORIS*

REPORT OF THREE CASES

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THREE cases of total thyroidectomy from the First Surgical Division of Bellevue Hospital are presented. One of these was for congestive failure and two for angina pectoris.

CASE REPORTS

CASE I.—A male, 49 years old, had had symptoms of heart disease for 12 years and had had to give up his work in 1926. In the period from 1930 to 1934 he was admitted to Bellevue six times for severe decompensation. In the intervals he was not suf-

* Presented before the New York Surgical Society, April 10, 1935.

ficiently well to work. At the time of his last admission he could walk only half a block or go up a few steps without resting, and was suffering from marked dyspnea, orthopnea, exertional precordial distress and palpitation. On examination he presented pulsating cervical veins, a hydrothorax which required tapping twice during his preoperative stay, and a liver enlarged to three and one-half fingers below the costal margin and for a time pulsating. There was marked edema of the extremities. The heart was enlarged, fibrillating, and showed signs of a double mitral lesion and of aortic insufficiency. The basal metabolism rate was $+11$.

Operation was decided on because of the increasing frequency with which hospitalization was becoming necessary and the diminishing degree of improvement with rest. Total thyroidectomy was done February 9, 1934. The surgical course was uneventful, aside from a slight wound infection. The precordial distress and palpitation were immediately improved and disappeared entirely after a week. Orthopnea was entirely relieved after 16 days. The liver remained down about two fingers, but did not pulsate and was not tender. He was discharged on the twenty-eighth day. Ten weeks later he had a recurrence of moderately severe signs of congestive failure—dyspnea, cough and edema. He was readmitted and discharged on the eighteenth day, relieved by rest, digitalis and salyrgan.

The metabolism rate was -17 for one week after operation, gradually falling to -42 eight weeks later, then rising to -24 six months after the thyroidectomy. Thyroid was started at this time, at first $\frac{1}{4}$ grain a day, later $\frac{1}{2}$. On this dosage the metabolism rate has varied between -17 and -26 .

Blood cholesterol has ranged between 330 and 380 mg. during the past eight months. Before that time it was 165 mg.

At present the patient is able to walk four blocks moderately rapidly without distress and can climb one flight of stairs. He has not required hospitalization for ten months, a longer period of freedom than any enjoyed during the preceding four years. While unable to undertake much physical exertion, he is free from palpitation and distress, as well as from edema and the discomfort resulting from an enlarged, pulsating liver. There is a mild degree of myxedema. Subjectively, he feels better than for some years. Although not a brilliant result, it is felt that the patient has been definitely improved and has been made more comfortable by operation.

CASE II.—A male, aged 54, had a coronary occlusion in 1925, was in bed four weeks, and unable to work for seven months at his occupation of an insurance agent because of cardiac pain. A similar attack in 1928 kept him in bed eight weeks. Since that time he has been unable to work because of exertional pain. The pain when first noticed in 1925 was precordial. In 1928 it began to radiate down the left arm and was brought on by exertion. Nitrites gave little relief. In 1932 attacks of pain began to come on while at rest, and at the time of his admission to Bellevue in 1934 attacks of pain occurred hourly or even more frequently. At this time walking ten steps on level ground would bring on an attack. There was moderate dyspnea and frequent attacks of dizziness with transient syncope. Sleep was frequently interrupted by attacks of pain.

On examination, blood pressure was 128/100; metabolic rate $+4$. The heart was slightly enlarged to the left. The electrocardiogram showed evidence of marked myocardial changes.

Operation was decided upon because of the steady increase in severity of the symptoms, which could be relieved only by morphine. Total thyroidectomy was done March 20, 1934. The postoperative course was uneventful except for a tracheitis. There has been no recurrence of the preoperative pain since operation, although there have been occasional mild sensations of precordial oppression following excessive exercise, none severe enough to be really disturbing. There has been no recurrence of dyspnea, edema, or palpitation, and the only comment about sleep is that he sleeps "too much."

The metabolic rate fell to -39 in four weeks, at which time signs of myxedema

appeared. Thyroid $\frac{1}{2}$ grain a day was started in the seventh week and dropped to $\frac{1}{4}$ grain after four months. At present his rate ranges between -10 and -30. Blood cholesterol was 165 mg. one month after operation, but now ranges between 260 and 370 mg.

This operation has been highly justified in this case as it has enabled a patient who had been compelled to give up his occupation for six years to return to a relatively normal life, free from pain.

CASE III.—A male, 46 years of age, had had cardiac symptoms since 1932 and had been forced to give up his work because of the steadily increasing severity of attacks of pain. These attacks were a stabbing paroxysmal pain radiating to the left arm and lasting from a few seconds to a few minutes. At first brought on only by exertion, they had latterly come on two or three times a day or night while in bed. He had been in bed for three months before admission to the hospital, and during this time had found immediate relief from amyl nitrite. Dyspnea, palpitation and heart consciousness had distressed him for over a year. He had been under treatment for two years in a diabetic clinic, but had not been given insulin on account of his angina. His blood sugar ranged from 185 to 224 mg. Basal metabolism was +11, his blood velocity 12 seconds, venous pressure 30 Mm. The cardiac diagnosis was arteriosclerotic heart disease, coronary sclerosis, angina pectoris, and anginal failure.

Operation was considered because of the increasing severity of the attacks in spite of prolonged bed rest, and was performed April 17, 1934. His postoperative course was complicated by a wound infection and by mild symptoms of tetany, easily controlled by calcium and viosterol.

The course of the diabetes was interesting in that, while the diet was unchanged, the blood sugar dropped to normal within 48 hours and the urine became sugar free. Since then the blood sugar has gradually returned to its previous level, but the urine has persistently remained sugar free.

The basal metabolism rate fell to -14 in the tenth week. At this time the patient complained of headaches and dizziness and thyroid was started $\frac{1}{4}$ grain a day. Since then, his rate has varied between -7 and -24 and there have been no severe symptoms of myxedema. The blood cholesterol now varies between 250 and 340 mg., blood velocity has decreased to 27 seconds, and the venous pressure to 41 Mm. The electrocardiogram shows no change.

Since operation, the patient has been free from pain except that in cold weather or after overexertion there is a mild sense of precordial pressure. This has never been severe, however, and is entirely different from the pain experienced before operation.

Comment.—In the last year Doctor Weeks, Doctor Grace and the author have operated on 16 of these cases, ten for congestive lesions, one of whom died, and six for angina. Of the surviving nine cases of congestive failure, two have been without result, in that after temporary improvement the subjective symptoms have recurred and the patients have gone back to bed life; three have been markedly improved, in that the symptoms of congestive failure were entirely relieved and they are in condition to go back to work; four have been moderately improved, in that the symptoms have been improved, although they have occasional attacks and have to resort to bed rest. These four, however, have not been able to go back to work.

Of the six angina cases there were no operative deaths, although one patient died three and one-half months after operation, presumably of coronary failure. This death emphasizes the fact that in doing this operation we

are not directly treating the disease, but are merely attempting to ease the symptoms for the time being. Of the other five patients, four have been markedly improved, in that they have been able to get about, have been free from pain, and have been able to return to work. One has been moderately improved, in that he has had moderate symptoms, occasionally having had to take nitrates, but considers his condition to be very much better.

The operation is done under block anesthesia rather than under local infiltration. At first, we did the operation from before backward, that is, we divided the superior and inferior thyroid vessels, freed the poles, cut the isthmus and then dissected the gland from before backward. But recently we have done it in the reverse direction, following the suggestion of Berlin and Blumgart, with the idea that although the operation is a little more difficult, nevertheless, in the cases where the line of the recurrent laryngeal nerve runs through the gland or between the gland and the zone of attachment to the trachea, it is probably easier to recognize it when we dissect the gland from behind forward. We have had one case in whom temporary parathyroid symptoms developed, easily controlled, and fortunately have not had any patients develop recurrent laryngeal paralysis.

It is an operation about which it is still a little early to be very dogmatic. We still do not know what our end-results are going to be, or how long these patients are going to be completely or partially relieved of their symptoms, but it is felt that it is of very distinct value in patients who have been bedridden and who face a life of considerable discomfort physically and, of course, economically. In many cases it is a procedure which we can offer with the feeling that we can relieve discomfort for the time being and perhaps bring the patient back to a moderately successful economic basis.

I do not know of any condition, not even including chest surgery, in which the liaison between the medical and surgical services has to be as close as in this type of case. It is the responsibility of the medical man to determine the operability of the individual, to get him into the best possible operative condition, and to look after him afterward. In addition to the necessity of coöperation between physician and surgeon, there must be the coöperation of the patient because we have to realize ourselves, and to make the patient realize, that the operation is not a cure, but merely one to relieve symptoms. The patient who has had a complete thyroidectomy must understand that he is going to be under medical care the rest of his life. The questions of activity, amount of thyroid, and the time when thyroid medication is to be given, are, of course, all questions that no one can determine beforehand.

One need not be limited in the length of the incision in connection with postoperative cosmetic results because it is important to obtain very free exposure of the gland. Particularly in congestive cases with dilated veins, it is very difficult to obtain complete hemostasis, and infection is perhaps a little more frequent than ordinarily is the case.

DISCUSSION.—DR. I. OGDEN WOODRUFF (New York) confessed to feeling a little on the defensive regarding so serious an operation in the treatment of so medical a condition as angina pectoris and congestive heart failure. In the first place, it must be realized that the operation is not done as an attempt to cure any condition, but to relieve patients from conditions in life that have become intolerable. Nevertheless, one must give the problem serious thought before deciding to put a man in a condition where he must be continually near a supply of thyroid and a doctor to prevent the development of a very serious state of myxedema.

In Bellevue Hospital it was decided that there were three groups of cases in which one might be justified in considering such an operation. In one is included patients who are continuously decompensated and who, despite all medical treatment, cannot be improved. In another group are those who become moderately comfortable while in bed under treatment and digitalization, but who, after getting up—particularly after leaving the hospital—even under the conditions of a very restricted life, become decompensated so that many periods of hospitalization are necessary. In the third group are the anginal patients who have repeated attacks over long periods of time, even on bed rest or on the slightest exertion, and who are little or not at all influenced by medication.

The first operations were done on patients in whom a proper degree of compensation could not be restored by bed rest, and these cases represent the particularly bad results, in that operation did not help to restore them. Neither was the procedure satisfactory in general in patients with hypertension, particularly essential hypertension, or with a luetic heart. The best type of patient for the operation is the one who improves on hospitalization but immediately breaks down after his discharge, it being advisable practically to limit the procedure to the type of case with rheumatic heart disease.

It is essential to have a well organized service to take care of these patients if good results are to be achieved. Care is required not only beforehand, but afterward there must be repeated determinations of basal metabolic rate to ascertain when thyroid should be started, the dosage to be given, and at what level to keep the metabolic rate and cholesterol. The quantity of thyroid required to prevent the operated patient from going into myxedema is much less than that required for the spontaneous myxedematous patient, and the patients operated upon do not have the electrocardiographic findings or anemic changes reported in other patients with myxedema.

Among interesting complications might be mentioned an inexplicable peripheral neuritis. With regard to the general principles upon which the operation is based it should be remembered that in hyperthyroidism with a metabolic rate of $+30$ the circulation time is about twice as fast as normal, whereas if the metabolic rate is -30 the circulation time is about half as fast as normal. Moreover, in patients with congestive failure the circulation time is about half as fast as when they are compensated. On the assumption that the symptoms present in decompensation might be due to the fact that blood is not supplied through the organs sufficiently rapidly to carry on metabolic activities of the body, it was thought that if metabolic activities could be brought down to a point where the heart could maintain the circulation adequately for the metabolic needs, the symptoms might be relieved. The same principle applies in the angina pectoris cases; that is, in coronary sclerosis the heart is not able to supply blood at a sufficient rate for the metabolic requirements of the heart muscle. By cutting down these needs

through removal of the thyroid, it was estimated that blood would be supplied sufficiently rapidly to take care of the needs with consequent disappearance of the symptoms. One or two points, however, are not yet entirely clear. In the first place, the relief of the symptoms in congestive heart failure comes very rapidly after operation, when there is practically no change in the amount of thyroid hormone in the circulation. In the angina pectoris group, as soon as the thyroid is removed from its bed, the patient states he has no pain though pain may have been experienced even on the table just previously. There would seem undoubtedly to be some association in these cases with the sympathetic system, this assumption being supported by the fact that angina pectoris patients are not nearly so sensitive to the injection of adrenalin following the operation as before. Doses that brought on an attack very readily prior to operation produce no response afterward.

DR. ALLEN O. WHIPPLE (New York) stressed a point of great therapeutic significance in the treatment of total thyroidectomy, that is, the placing of the patient in an oxygen atmosphere for two to three days before operation and for several days after it. This therapy takes a considerable load off the circulation by supplying the individual with oxygen both before and after operation and is particularly valuable in cases of cardiac congestion due to valvular disease.

DR. SEWARD ERDMAN (New York) asked whether some of the benefits encountered after operation might not be due, in part, to the unusual guidance, medication and check up that these patients are receiving.

DOCTOR MCCREERY said that although the oxygen tent had not yet been used at Bellevue Hospital, they expected to use it very soon. He admitted that the definitely subjective improvement during and immediately after operation might be due partially to excessive preoperative care, but could not believe it to be the entire explanation.

DR. CARNES WEEKS (New York) said that the employment of total thyroidectomy in the treatment of heart disease was only a little over two and one-half years old. A questionnaire sent by him to various clinics where the operation might have been done developed that it had been performed 250 times in 26 clinics throughout the country with a surprisingly small immediate postoperative mortality. In the few cases that developed parathyroid tetany this was apparently transient and mild, being controlled by viosterol and calcium therapy. The number of recurrent nerve injuries was also astonishingly small. The appended three tables summarize the answers to this questionnaire.

TABLE I

Statistical Questionnaire on Total Thyroidectomy for Heart Disease

(Operation done in 26 clinics)

Total number of operations.....	250
Operative mortality.....	6.8%
Complications:	
Parathyroid tetany.....	8
(Transient, mild, controlled by viosterol and calcium therapy)	
Recurrent laryngeal nerve paralysis.....	13
(Four temporary)	

TABLE II

Results of Total Thyroidectomy for Congestive Heart Failure

(Operation done in 26 clinics)

Number of cases.....	150
Deaths:	
Immediate.....	14- 9.3%
Late (not related to operation).....	24-16%
Clinical results in 112 patients:	
Markedly improved.....	47-41.9%
(No recurrence of signs of symptoms of congestive failure: able to work)	
Moderately improved.....	44-39.2%
(Attacks of congestive failure less frequently and less severe; unable to work)	
No improvement.....	21-18.7%

TABLE III

Total Thyroidectomy for Angina Pectoris

(Operation done in 26 clinics)

Number of cases.....	100
Deaths:	
Immediate.....	3- 3%
Late (not related to operation).....	15-15%
Clinical results in 82 patients:	
Markedly improved.....	42-51.2%
(No pain, no nitroglycerine, normal activity)	
Moderately improved.....	33-40.2%
(Mild attacks of pain at irregular intervals, occasional use of nitroglycerine)	
No improvement.....	7- 8.5%

HIRSCHSPRUNG'S DISEASE*

FRANK L. MELENEY, M.D.

NEW YORK, N. Y.

CASE REPORT

E. C., a college boy of 18, was admitted to the Presbyterian Hospital February 3, 1934 (No. 405406), with a history of abdominal distention existing since birth. He had never had a spontaneous bowel movement. By sheer grit and determination his father had managed to keep him alive. During the first few years it required daily or twice daily bowel irrigations to relieve the distention. When 20 months old he was studied by Doctor Holt in the Babies' Hospital because of emaciation, distention and vomiting. At that time his hemoglobin was down to 10 per cent. He was transfused, but this did not seem to benefit him greatly, and he was expected to die. However, his father persisted in controlling the distention and he began gradually to improve. Although he was always embarrassed and handicapped by his large abdomen, he grew stronger gradually. His mental development had been normal.

Three years before admission, a barium enema revealed an enormously dilated colon

* Presented before the New York Surgical Society, April 24, 1935.

on the left side. With colonic lavage once or twice a week during the past few years, there has been some improvement in the degree of distention. A subsequent radiogram taken one and one-half years before admission seemed to indicate some reduction in the size of the colon, but there had never been any impulse for a spontaneous evacuation and the patient was determined to have something done, if possible, to relieve the condition. With the many reports, in the recent literature, of favorable results following lumbar ganglionectomy in similar cases, we advised operation, explaining to the parents that the results had been more satisfactory in younger than in older patients.

At operation February 5, 1934, under spinal anesthesia, it was found that the dilatation began abruptly at the middle of the transverse colon and extended down to the lower sigmoid, corresponding closely with the distribution of the inferior mesenteric vessels. The greatest dilatation was present in the sigmoid, which measured approximately 20 cm. in diameter. Without much difficulty, the left sympathetic cord was resected to include the second, third and fourth lumbar ganglia.

The patient made a very satisfactory recovery from the operation, but we were frankly disappointed when there was no resultant improvement in evacuation. A barium

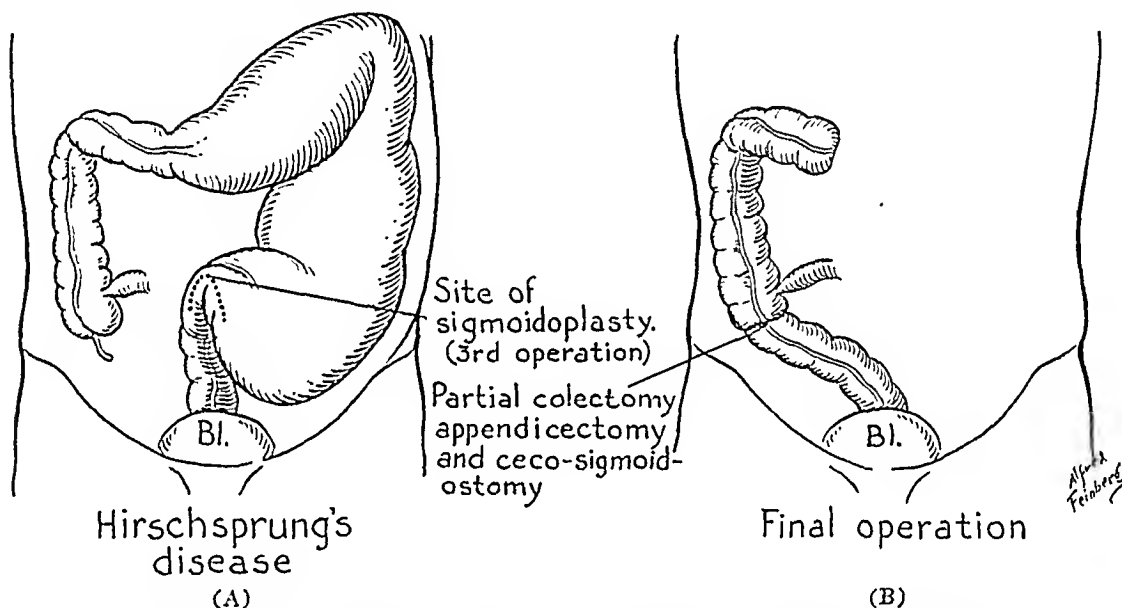


FIG. 1.—(A) Site of sigmoidoplasty performed at the third operation. (B) Showing anatomic result, after partial colectomy and ceco-sigmoidostomy (fourth operation).

enema two weeks after operation revealed a considerable reduction in the size of the colon but a failure to fill the lower segment. In the erect posture, the dilated portion hung down as a bag, evidently angulating the gut at the point of constriction. He was able to expel enemata, however, and was sent home with the expectation that he would improve under antispasmodics and retention oil enemata. Instead, the condition became steadily worse. Finally, after six weeks, he ceased to respond at all to enemata and came in again for roentgen study. This revealed more dilatation than at the previous examination and it was felt that an attempt should be made to assist the emptying of the dilated proximal portion into the distal contracted portion.

On April 9 a right-sided lumbar ganglionectomy was performed and the pre-aortic sympathetic fibers as well as those on the inferior mesenteric artery were cut. The dilated sigmoid was sutured by a series of silk stitches to the anterior abdominal wall. Again there was no immediate result but after two weeks he began to have spontaneous bowel movements for the first time. Improvement was transient, however, and it soon became apparent that the result would not be satisfactory. The distal sigmoid and rectum would not fill and the dilated portion would sag when he assumed the erect position. We attempted to dilate the narrow portion with rubber rectal bougies, but this merely resulted in pain and further constriction. On June 28 we performed a third operation

which was designed to make a larger opening between the dilated and constricted portions of the sigmoid. We protected the peritoneum by two injections of stool culture filtrate—one on the day before and the other on the morning of operation. When the peritoneum was opened, the expected purulent exudate was abundant. A curved incision was made, in a manner similar to that of a Finney pyloroplasty, and a large opening obtained (Fig. 1, A).

The patient recovered promptly from the operation and the wound healed without infection, although the fecal material still refused to pass into the distal segment. All that the operation accomplished was to bring the constriction lower down. After this failed to function, we again attempted dilatation and the boy's father continued this treatment throughout the summer. In the fall, however, the problem was still unsolved and it was decided to remove the diseased gut.

On October 23 the dilated gut was resected from the proximal transverse colon to the site of anastomosis. The distal sigmoid was then sutured to the cecum (Fig. 1, B), the appendix removed and a tube put into the cecum for a safety valve. The result was eminently satisfactory. The cecostomy tube functioned well. On the eighth day rectal lavage was administered and fecal material began to come down without difficulty. The cecostomy tube was removed on the eleventh day and two days later all of the fecal matter came through the rectum and was easily expelled with the aid of low enemata. On the sixteenth day he had a large spontaneous bowel movement and ever since then has had one or two spontaneous evacuations daily. He has gained rapidly in strength and weight, and in February, 1935, he returned to college. During the spring, summer and fall his bowel functioned normally.

DISCUSSION.—DR. EDWARD J. DONOVAN (New York) thought that it was difficult to understand why the ganglionectomy was not more successful in Doctor Meleney's case, but this occasionally happened. When talking to Doctor Adson of the Mayo Clinic about their cases of Hirschsprung's disease, he was informed that they had operated upon 20 cases with very gratifying results with the exception of one or two instances in which the results were rather disappointing in spite of the fact that they had done a ganglionectomy in addition to removal of the presacral and inferior mesenteric nerves.

Personally, he had had five cases, the first four being very successful and the fifth too recent to report upon. The first case was one in which Doctor Bolling had resected 48 cm. of the sigmoid for Hirschsprung's disease when the patient was ten years of age. There was a very prompt recurrence of the symptoms after this operation. When the boy was 22 years old Doctor Donovan performed a sympathectomy with excellent results. That was more than three years ago and he has had a normal bowel movement daily. The succeeding three cases were in children in whom the results were excellent.

Although not giving a good result in every case, Doctor Donovan felt that sympathectomy was very much better than the old method of resection of the intestines. Not only is the latter a rather severe operation to do on a child, but the results were very discouraging as exemplified by two cases of resection of the sigmoid for Hirschsprung's disease shown by Doctor Bolling before the New York Surgical Society, both of whom had recurrence of their trouble within a year.

DOCTOR MELENEY expressed his opinion that the reason that the results may be unsatisfactory in patients older than 12 years is because in the long period of time in which there has been great distention of the gut with the trauma that results from colonic irrigations, the wall of the gut develops extensive fibrosis so that even though the physiology may be restored by sympathectomy, the pathology represented by scar tissue in the wall, prevents

normal function. He felt that in the case reported it would have been better to have resorted directly to the resection after the first failure rather than to have attempted the other two conservative operations.

PRESACRAL SYMPATHETECTOMY FOR OBSTINATE CONSTIPATION *

J. WILLIAM HINTON, M.D.

NEW YORK, N. Y.

CASE REPORT

A young woman, 28 years of age, first examined May 31, 1932, complained of nervousness, irritability and inability to stand cold weather. For two months previously she had been treated for thyroid disease.

Past History.—The patient is married and has one child eight years of age. She had had no serious illnesses or surgical operations, but gave a history of constipation from birth, stating that for the first three months of her life she had never had a normal bowel movement and during childhood and adolescence had never had a movement without the aid of a cathartic. The constipation had grown gradually worse.

Physical Examination.—The eyes were negative for exophthalmos. There was no thyroid enlargement and no thrill over the neck. The skin was not flushed. There was no tremor of the fingers. The pulse was 80, the blood pressure 110/70. There was no definite evidence of thyroid disease except her basal metabolism was -11 . Her abdomen was not distended, contained no masses and tenderness could not be elicited. Rectal examination was negative.

In view of her minus metabolism and marked constipation, the patient was treated with thyroxine 1 mg. intravenously once a week for six injections and given thyroid Gr. 1, T.I.D. Although her basal metabolism on July 19, 1932, was -4 , the patient did not notice definite improvement in her symptoms. Between July 19 and October 7, 1932, thyroxine was given every two weeks and thyroid Gr. 1, B.I.D. On October 7 her basal metabolism was -2 and she complained of nervousness on taking the thyroid by mouth. This was discontinued and on November 3 her basal metabolism was -8 . She was then given thyroxine 1 mg. every two weeks without thyroid by mouth, but her general symptoms and constipation did not improve.

Radiographic examination, December 2, 1934.—A film of the abdomen before any barium was administered showed a large loop of the left side of the colon filled with gas and considerable accumulation of fine grained gaseous and solid material in the sigmoid. A barium enema showed a large colon, though not to the degree of a true megacolon. The sigmoid is fairly long. By turning the patient in different positions, it was possible to visualize all of the colon quite satisfactorily, and no filling defects were found that could not be accounted for by fecal material. A small amount of barium passed into the ileum. A film made standing after evacuation showed the splenic flexure in the normal position and the hepatic well above the crest of the ileum directly beneath the apparently normal liver. Much barium was still in the colon and fluid levels of barium, water, and gas were found in several places in the colon. The appendix was not recognized. This is a case of apparently simple enlargement of the colon to about double the normal diameter, with moderate elongation. The expulsive function was poor.

Thyroxine was discontinued and the patient was given tincture of belladonna without any relief. At this time the suggestion was made that an operation might be needed

* Presented before the New York Surgical Society, February 27, 1935.

to cure the constipation and the patient readily assented. However, I hesitated to subject her to a presacral sympathetectomy, being dubious of the result. On March 2, 1933, her basal metabolism was — 15. She was again put on thyroxine once every two weeks and thyroid Gr. 1, B.I.D.; this was continued until April 30, without benefit. The patient then entered the Post-Graduate Hospital for operation.

Operation, May 1, 1933.—The abdomen was opened through a midline incision. The posterior peritoneum over the aorta was then divided. The aorta and division of the iliacs were exposed and all the sympathetic fibers over the aorta were removed. Tissue on both the right and left sides resembling sympathetic ganglion was excised. An appendectomy was done.

Diagnosis.—Chronic productive inflammation of vermiform appendix resulting in atrophy and obliteration of the lumen. Mild chronic productive inflammation of lymph nodes with resulting atrophic changes. No sympathetic nerve fibers or ganglion cells were recognized in these sections.

Postoperative Course.—No cathartic or enema was given until the seventh day post-operative when an enema was very effectual. Since then none has been necessary, or any cathartics, the bowel movements having been regular and the patient entirely well except that for the past four or six weeks she has been slightly constipated, but not in a degree to compare to the previous condition.

A barium enema February 25, 1935, revealed the following: "A great deal of fecal matter is present. Without the previous films for comparison, I cannot say just what difference there is from the examination on December 2, 1932, before the sympathetectomy, but I would say that this colon is double the normal diameter. There is quite a long sigmoid which does not show any evidence of organic disease. The patient expelled some of the enema and films showed considerable remaining. She then expelled more and the final film after evacuation does not show a great deal remaining. The left side of the colon was considerably wider than normal during and after the enema. It did not empty out its fecal contents as well as it should. As before, some barium passed into the ileum."

Comment.—It is emphasized that this patient had gas-oxygen-ether anesthesia and so the result, therefore, cannot be attributed to the effect of spinal anesthesia on the sympathetics. A long follow up in all these cases is most important.

DISCUSSION.—DR. EDWARD W. PETERSON said that a woman who, after being constipated all her life, had had two years of relief from her constipation following sympathetectomy is a splendid result, even though she may be having slight trouble at present.

It is to Royle, an orthopedic surgeon, and to the late John Hunter, an anatomist, both of Sidney, Australia, that credit is due for the revival of and continued interest in surgery of the sympathetic nervous system. Royle attempted to relieve the spasticity or rigidity following war wounds of the central nervous system and reported encouraging results following lumbar sympathetic ganglionectomy. Unfortunately, the promise of benefit was not confirmed by many other workers in this field. Two interesting observations, however, resulted from this work: (1) the capillary circulation was increased and the temperature of the skin was permanently elevated in a sympathetomized limb; and (2) obstinate constipation, when present, was relieved in selected cases.

Applying this knowledge, Adson of the Mayo Clinic in March, 1925, operated upon a case of Raynaud's disease of the lower extremities, and, in 1926, Wade and Royle operated upon a case of Hirschsprung's disease, doing lumbar sympathetic ramisection, with an excellent result. Following a re-

port of this case, Adson, Judd, Rankin and Learmouth, of the Mayo Clinic, Wade, Scott, and surgeons in this country and abroad, reported encouragingly upon their experience with this operation. Three cases of Hirschsprung's disease successfully treated by lumbar sympathetic neurectomy were also reported by Doctor Peterson in 1933 at a joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery. More recently, Doctor Peterson said, a fourth case was operated upon by him with a satisfactory immediate result.

The method proposed by Wade, the original operator, was an extraperitoneal division of the paravertebral sympathetic cord below the fourth ganglion, with a division of all of the medially directed rami up to the level of the inferior mesenteric artery, through a long incision in the flank. Adson and Judd advocate, through an abdominal approach, bilateral ganglionectomy of the second, third, and fourth lumbar ganglia. Rankin and Learmouth believe that resection of the presacral and inferior mesenteric nerves will sever all of the branches to the parts of the bowel chiefly affected, thus avoiding the minor disadvantage of disturbing the neurovascular supply to the lower extremities. Doctor Peterson stated that there could be no question as to the value of this operation as performed by Doctor Hinton, in properly selected cases.

THE MATAS OPERATION IN THE TREATMENT OF ILIAC, FEMORAL AND POPLITEAL ANEURYSMS *

JOHN H. GIBBON, M.D.

PHILADELPHIA, PA.

DOCTOR GIBBON said that he had been impressed with Matas' early contributions on the treatment of aneurysm and has often regretted that the important principle laid down by him of dealing with the aneurysm from within the sac had not been more universally applied. During the late War, for instance, where there was extraordinary opportunity to apply the method, it was seldom used, particularly in the American Army. The French employed ligation and extirpation. Sencert reported 93 cases of extirpation during the War with nine cases of gangrene and says that gangrene is more frequent after ligation than after extirpation. The intrasaccular method was used by the Germans to some extent, but far less frequently by the French, English or Americans.

Doctor Gibbon did his first endo-aneurysmorrhaphy in 1904, and since then has done but two primary ligations for aneurysm of the lower extremity. The first was a case of popliteal aneurysm where a physician had punctured it, thinking it an abscess, and where there was a suppurating superficial wound on the front of the knee. Patient had fever and a leukocytosis. In the second case, the common iliac was ligated for a huge aneurysm of the external iliac which practically filled the pelvis.

Since 1904, he has done 22 obliterative endo-aneurysmorrhaphies on the large vessels of the leg. Eighteen of these were included in a paper read

* Read before the Joint Meeting of the Philadelphia Academy of Surgery and the Boston Surgical Society, February 4, 1935.

before the American Surgical Association in 1924. The distribution as to site was as follows:

Ileofemoral.....	2
Femoral.....	12
Popliteal.....	8

Deaths.—There were three deaths following operation; one was an anesthetic death just at the conclusion of the operation; one occurred 15 days after operation and 24 hours after a ligation of the femoral artery for secondary hemorrhage from the site of an obliterated popliteal aneurysm. The patient was in good condition following ligation and died very suddenly the next day; the autopsy showed a vegetative endocarditis and a splenic and renal infarction. The third death was in an extremely ill leucic Negress with a femoral aneurysm. The operation was done under local anesthesia because of a very grave cardiac condition. One week after the operation she had a hemorrhage from the site of operation which was controlled by reopening and resuturing. She died suddenly the next day without any more bleeding or any symptoms indicating impending death. The autopsy findings were acute and chronic endocarditis and aortitis; hypertrophy and dilatation of left ventricle; infarction of spleen and kidneys; atrophic cirrhosis of liver and vesicular emphysema of lungs.

Six of the 22 aneurysms were traumatic and three of these arteriovenous.

Gangrene. Amputations. Secondary Aneurysms.—In none of these cases, even in the fatal ones, did gangrene occur, and in none was amputation done. Most of these patients have been traced since operation and no secondary aneurysm has developed.

Postoperative Hemorrhage occurred in several cases, usually from one to three weeks after operation. Two resuturings failed and ligation was done, in one successfully. These later ligations are less apt to cause gangrene than primary ligation. In his experience, the traumatic arteriovenous aneurysms are more apt to bleed after operation than the others.

Technic.—Doctor Gibbon feels that from his experience the oblitative operation, because it is simpler and safer and gives satisfactory results, is preferable to the restorative and reconstructive operations in the vessels under consideration. Exception to this might be made in the case of saciform traumatic aneurysms and in certain arteriovenous aneurysms.

Control of Circulation.—The Matas operation is applicable wherever the circulation can be controlled during its performance. Doctor Gibbon felt very strongly that in aneurysms due to a diseased vessel all forms of mechanical control of the circulation were dangerous. Digital compression with or without exposure of the artery above the aneurysm was the method employed by him in all luetic aneurysms and in several of the traumatic ones. In the iliac and femoral aneurysms the abdomen was opened and the common or external iliac compressed by an assistant. He felt that any mechanical appliances such as tapes or clamps might be injurious to the diseased vessel

and recalled that there were several instances reported where an aneurysm subsequently developed at the site where such appliances had been used.

DISCUSSION.—DOCTOR DAVID CHEEVER (Boston, Mass.) wished to know if traumatic aneurysm did not lend itself to endo-aneurysmorrhaphy as well as the luetic or spontaneous type. Recent traumatic aneurysm has not the firm wall to work in.

DOCTOR GIBBON.—Recent traumatic aneurysms are just as easily operated on by this method and give excellent results; the long standing ones are more difficult. The traumatic type lends itself to the restorative operation of Matas in which the caliber of the vessel is preserved. He has never done the reconstructive operation, although he had tried it once unsuccessfully in an aneurysm of the abdominal aorta.

DEFORMITY DUE TO LOSS OF SUBSTANCE OF THE MANDIBLE FOLLOWING OSTEOMYELITIS*

ROBERT H. IVY, M.D., AND LAWRENCE CURTIS, M.D.

PHILADELPHIA, PA.

CASE REPORT.—E. B. female, aged 27, single, applied in June, 1933, for correction of faeial deformity. At seven years of age she had osteomyelitis of the left side of the mandible, due to dental infection. Had several operations at that time. The end-result was loss of a segment of bone and several teeth on that side of the lower jaw. At ten years of age an unsuccessful attempt was made to restore the lost continuity by a rib graft. Since then she has been unable to use her lower jaw for mastiation, and there has been a gradually increasing visible deformity, due to displacement and lack of growth of the mandible.

Examination in June, 1933, showed a retrusion of the chin and lower lip, which was overlapped by the upper teeth. The chin was drawn over to the left side. There was a concavity of the left cheek, extending from in front of the ear toward the chin (Fig. 1). Only three teeth remained in the lower jaw—the right second incisor, canine and first premolar. With the mouth closed these teeth were found to be drawn toward the left and posterior to the upper teeth so that there was no contact. Abnormal mobility of the mandible existed at about the region of the left mental foramen, and there appeared to be a gap in the bone from this point backward. Posteriorly, the left ascending ramus could be felt as an independent unit. The main fragment of the mandible was bound over to the left by scar tissue so that it was impossible to reduce it completely by manipulation.

Roentgenologic examination showed a gap in the left side of the mandible, beginning at about the region of the mental foramen, and extending to the angle. Running forward from the ramus segment and extending about halfway across the gap was a thin piece of bone, probably the remains of the rib transplant (Fig. 2).

Treatment.—In this case three distinct procedures were required: (1) Restoration of remaining fragments of the mandible to correct as nearly as possible the relationship with the upper jaw. (2) Restoration of the continuity of mandible by bone graft. (3) Improvement of the external symmetry of face.

(1) June 15, 1933, in the Graduate Hospital, the scar tissue binding the main part of the mandible over to the left was divided. This freed the bone and permitted slight overcorrection. Arch-bars were applied to the remaining lower teeth and all of the

* Read before the Philadelphia Academy of Surgery and the Boston Surgical Society, February 4, 1935.



FIG. 1.—External appearance before operation.



FIG. 2.—Roentgenogram showing defect in mandible before operation.

upper teeth, and the two fastened together in a slightly overcorrected position. A waiting period was now necessary to allow complete healing of the mouth incision.

(2) July 27, 1933, under avertin-ether anesthesia, a three-inch skin incision was

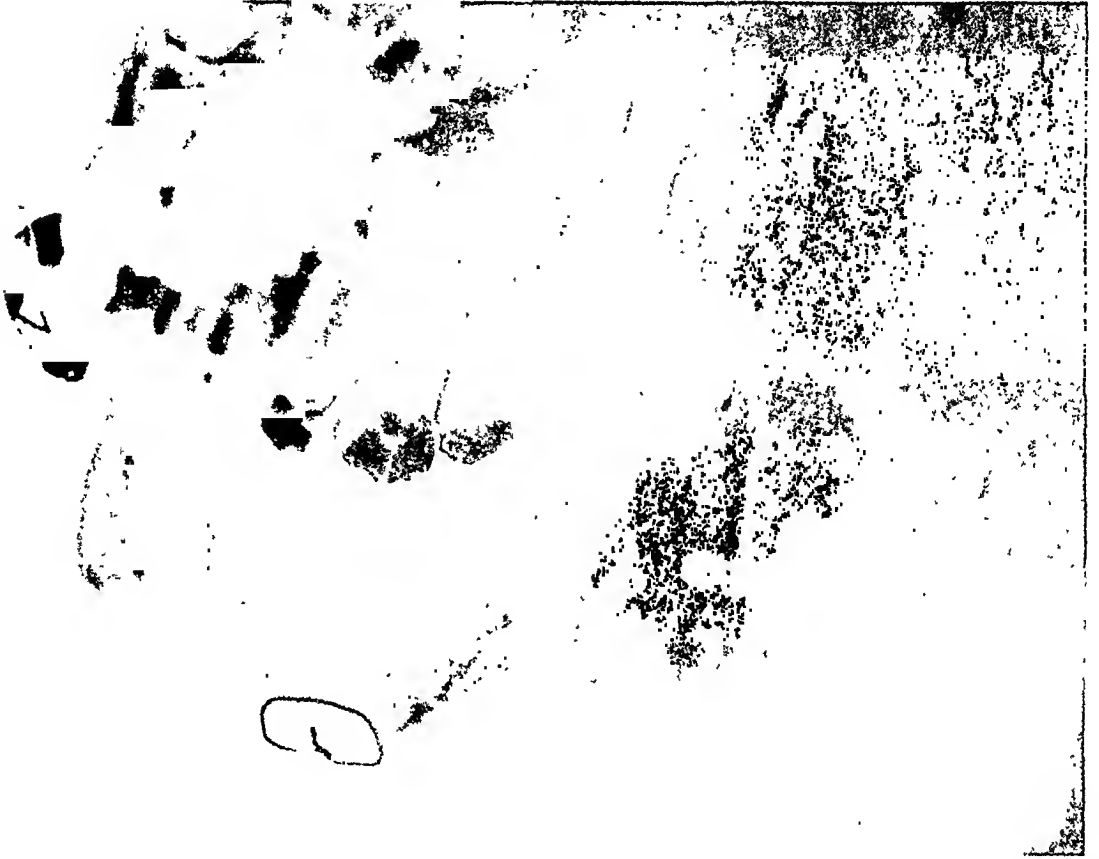


FIG. 3.—Roentgenogram showing defect filled by graft from crest of ilium, made along the lower border of the mandible on the left side, and the gap exposed, care being taken not to perforate into the mouth. Scar tissue was removed, revealing the stump of the main mandibular fragment and the remains of the rib graft. These were



FIG. 4.—External appearance after operation.

thoroughly denuded of periosteum, the anterior stump being exposed for about three-quarters inch, and the outer surface of bone posteriorly being denuded to give a broad exposure back toward the ascending ramus. A bone graft, two and one-half inches

long, was removed from the crest of the left ilium with a metacarpal saw and chisel, and after trimming to suitable shape, was attached to the anterior fragment of the mandible by fine brass wire passed through holes drilled in the bone and in the graft. Posteriorly, the graft was laid against the outer surface of the ramus segment, in close contact (Fig. 3). The wound was closed in two layers, without drainage. Healing was uneventful (Fig. 4). The patient left the hospital after two weeks, and soon recovered full use of the limb from which the graft had been taken.

October 9, 1933, the fixation was removed from the teeth. Union of the graft was found to be firm, and the mandible stable, with good movement at the joints. Following this, a lower artificial denture was made, to restore the missing teeth.

(3) The bone graft filled out the concavity of the left side of the face, but there was some flattening to the right of the chin, due to distortion of the mandible from prolonged fixation in malposition.

March 16, 1934, under ether anesthesia, a piece of costal cartilage was inserted in a subcutaneous pocket against the outer surface of the mandible to the right of the chin. This had the effect of improving the symmetry of the face. Patient left the hospital after ten days. At present she has a greatly improved appearance, and her lower jaw has been put in a condition to function with an artificial denture.

DISCUSSION.—DR. VARAZTAD H. KAZANJIAN (Boston, Mass.) thought that cases in which the mandible was distorted owing to loss of bony tissue presented great difficulties. The mandible is a movable bone, and isolated segments of it are difficult to control. It is necessary to make intricate dental splints to immobilize the parts before the operation. In this case Doctor Ivy used a block of bone graft taken from the ilium. It had been the speaker's habit, in cases requiring extensive bone graft of the mandible, to use a series of thick osteoperiosteal grafts from the tibia, placed one over the other and held in position by suturing to the adjacent soft tissues with catgut. This was not a criticism of Doctor Ivy's method, but merely showed another way of accomplishing the same result. It was the speaker's impression that a series of osteoperiosteal grafts made a more flexible transplant, and as a result, the problem of immobilization was simplified.

MEMOIRS

JOSHUA CLAPP HUBBARD

1869-1934

JOSHUA CLAPP HUBBARD was born in Charlestown, New Hampshire, on December 31, 1869, the son of Richard and Sarah Denny (Clapp) Hubbard.



JOSHUA CLAPP HUBBARD, M.D.

He received the degree of A.B. from Harvard College in 1892 and M.D. from the Harvard Medical School in 1896. He served as Surgical House

Pupil at the Massachusetts General Hospital and later as Interne at the Boston Lying-In Hospital. Immediately after finishing his tour of duty at the Boston Lying-In Hospital he began the practice of his profession in Boston. While his chosen field was general surgery, he kept up an active but gradually decreasing interest in obstetrics.

During his early career he served on the staffs of various hospitals, the Boston Lying-In, the Carney, and the Infants'. Later he became Visiting Surgeon to the Boston City Hospital, Surgeon to the Newton Hospital and to the Leonard Morse Hospital in Natick, and Consulting Surgeon to the Norwood Hospital.

He began to teach in the Harvard Medical School in 1903 and continued in various positions, with one or two short interruptions, until 1924, when he was made Clinical Professor of Surgery. He was obliged to resign this position in 1928 because of increasing ill health, and at that time was made Professor Emeritus.

Doctor Hubbard's military service, while not long, was highly creditable. He entered the Medical Reserve Corps U. S. A. in January, 1917, as a Major, and taught medical officers in Boston until he sailed for France with Base Hospital 85 on September 8, 1918. On his arrival in France he was promoted to Lieutenant-Colonel, M. C. U. S. A. He was stationed at Paris and Angers with Base Hospital 85 and later at Sebastopol Barracks with Evacuation Hospitals 1 and 37 as Chief of the Surgical Service. He was discharged at Camp Dix on May 15, 1919.

During the early part of his foreign service he was seriously ill with influenza, from which he never fully recovered. A severe arthritis followed and this in turn was followed by a rapidly progressing Parkinson's disease, from which he died on January 11, 1934.

During the early years of practice he wrote a moderate number of sane and valuable articles on surgical subjects, but this activity lessened as he became more and more occupied with his teachings and practice, and ceased when his health began to fail.

Doctor Hubbard was a typical New Englander with all the best qualities of that individual. Endowed with a Puritan conscience, he was honest beyond most men not only in his everyday life but also in his surgical work and teaching. Kindly and sympathetic beyond our ideas of the Puritan who was kindly and sympathetic toward those who believed as he did, Doctor Hubbard was kindly and sympathetic toward his patients, colleagues, and all those with whom he came in contact. A colleague has said of him that he doubted if any one ever heard him make an unkind or critical remark about a colleague. It was not in him to do so. He was modest beyond all reason.

What better qualities in addition to his professional attainments, which were considerable, could a clinical professor bring to his students? As a teacher he was earnest and able and was tremendously admired. He gave his students what they wanted and needed in a simple direct way which made his teaching effective. They were given a background for their professional

careers which should carry them safely over many rough places. It is to be hoped that these qualities so outstanding in Doctor Hubbard will always remain essential to the Clinical Professor of Surgery for they are needed by the men who must go out among people to care for them.

In surgery his method was simple, direct, and effective. This added to rare judgment and an excellent sense of proportion made him of great value to the community and to his students.

Doctor Hubbard was devoted to his profession, colleagues, and friends. Nothing was too hard for him to undertake in the interest of his friends or patients, and his kindliness, understanding sympathy, and surgical skill will always be remembered by his patients.

While all this is true of him, he was unusually devoted to his family and spent every possible moment with them at his place in the country. He was a lover of all out of doors.

His sterling qualities and their influence upon his colleagues, friends, and students have done much to make the world a better place to live in.

DANIEL F. JONES.

JABEZ NORTH JACKSON

1868-1935

JABEZ NORTH JACKSON was born in the little village of Labaddie, Missouri, on the sixth day of October, 1868. He died at his home in Kansas City on March 18, 1935.



JABEZ NORTH JACKSON, M.D.

The Jackson family came to Missouri from Virginia in the early days of Mid-Western settlement. Doctor Jackson's father was a physician of the pioneer type, serving for many years a small rural community and later as a Major with the Union Forces during the Civil War.

Doctor Jackson received his Bachelor of Arts and Master of Arts degrees from Central College, Fayette, Missouri. In 1891 he was graduated in medicine at the University Medical College in Kansas City, Missouri. Immediately following graduation he served his medical school as demonstrator in anatomy for several years and later became Professor of Anatomy. From 1900 to 1911 he held the chair of Professor of Principles and Practice of Surgery. For twenty years he was a Trustee of the University Medical College and during a portion of this time served as its President.

In 1927 Doctor Jackson was elected President of the American Medical Association. In addition to this honor he has successfully held the office of President in the Western Surgical Association, Missouri State Medical Association, county and various local medical organizations. He has received the honorary degrees of Doctor of Science and Doctor of Laws. He was a foundation member of the American College of Surgeons. Being the son of an army surgeon, Doctor Jackson inherited an interest in military affairs. He served as Major in the Spanish-American War in 1898. Both before and since he has been active in local military organizations and was for years, before his death, a member of the Medical Reserve Corps.

Doctor Jackson's best known contributions to surgery have been his description of membranous pericolicitis (Jackson's membrane) and a technic for breast amputation.

Among his friends and associates Doctor Jackson was always a favorite. In his later years he was affectionately called "Uncle Jabez" by his younger confreres in medicine. One of his outstanding characteristics was his unflinching loyalty to his friends. He was especially interested in the progress of the younger physicians, aiding and advising them whenever possible. He always preached the gospel of honesty in medicine. No man was ever more ready to rise to the defence of the medical profession when quacks, cults and isms threatened its high standing. He will forever live in memory as a surgeon, loyal friend and distinguished citizen.

THOMAS G. ORR.

JOHN EDWARD SUMMERS

1858-1935

JOHN E. SUMMERS died at his home in Omaha, Nebraska, on February 7, 1935, at the age of 77. He was born at Fort Kearney in the same state, in which for so many years he practiced his profession of surgery. His



JOHN EDWARD SUMMERS, M.D.

father was General John E. Summers of the Medical Corps of the United States Army. Amid such military surroundings, it was natural that he elected to follow an Army career. He entered West Point, but after three years re-

signed to matriculate at the College of Physicians and Surgeons in New York, from which school he graduated in 1881. The Army still called and he became an acting assistant surgeon. After serving nearly two years in the frontier posts of Wyoming, he again resigned and spent two years of study in Europe, chiefly in Vienna, returning in 1885 to locate in Omaha.

From data obtained from the Nebraska State Medical Journal of April, 1932, an issue honoring Doctor Summers, a formal statement is made of his many activities.

In 1887 he joined the faculty of the Omaha Medical College, was elected trustee in 1890, became Secretary of the Faculty in 1891 and President of the Board in 1897. He resigned in 1902 when the school affiliated with Nebraska University, to return later as Professor of Clinical Surgery, when the four year course in medicine was established, a position he held all through life. He was Past President of the Nebraska State Medical Society and the Medical Society of Missouri Valley; charter member and Past President of the Western Surgical Society, a member and in 1916 Vice President of the American Surgical Association; a Fellow and member of the Board of Governors of the American College of Surgeons and member of the Association of Military Surgeons. He was Surgeon in Chief and Senior Surgeon to the Clarkson Hospital, and for many years Chief Surgeon of the Douglas County Hospital; was on the staffs of the Immanuel and Wise Memorial Hospitals. He was at one time Surgeon General of the Nebraska National Guard. An Honorary Doctor of Laws degree was conferred upon him by the University of Nebraska.

Doctor Summers was a frequent contributor to the progress of medicine and surgery. His many formal papers cover a wide range of endeavor. He was the author of one book, "The Modern Treatment of Wounds." The records of his societies show many discussions of the efforts of others, an index of his general interest and ability. A computation of his book reviews runs to extraordinary figures.

In the 1880 period, in the Mid-West, surgery was on the threshold of the era of advancement and change in study and research, an effort which we now recognize as scientific medicine. The clinical men of that period had no recourse to the many refinements of diagnosis and technic that are at hand today. They were individual men, who depended upon their own judgment and experience. The form of practice was based so often on empiricism, the facilities of conduct were limited. Amid such surroundings came a young man trained by the discipline of the Army, by the best obtainable instruction of the Old World. He brought not only the ability to care for the ordinary run of surgical cases, but of special operations as well. In 1931 he wrote a paper entitled "Wayside Gleanings of a Pioneer Surgeon," a review of his work of over 46 years. He was the first to use the laryngoscope, the first to correct a wry neck, operate with recovery of the youngest patient for acute appendicitis, to do the first nephrectomy, the first choledoco-enterostomy, *etc.*

He became associated with the hospital and medical schools soon after his

arrival with ever-increasing interest as shown by his promotion to positions of responsibility in the conduct of their affairs of the institutions and the form of teaching in the schools.

Through the Western Surgical Association, of which he was a Charter Member, I came to know him as a most courteous gentleman, soft spoken, an attentive listener, a wise advisor. He was loyal and faithful in his duties and commitments. His contributions were of such merit, so well prepared that his name on the program brought a most attentive audience.

I felt that he had a high purpose in his profession, that no matter what the encouragement of reports of new methods of treatment, that his was a conservative attitude, which required careful weighing of new data and yet with all a progressive spirit of an open mind. The circumstances of his early practice, the development of his many innate faculties to the highest degree of efficiency as a surgeon, place him in that fast-disappearing group who pioneered in their respective fields, helped to sift and evaluate over the years, the findings of research and experiment and apply these findings to the clinical problems of his patients. Such a career—such a record of work—can be gained only by a heartfelt purpose and can be maintained only by the respect and appreciation of his fellows.

HARRY P. RITCHIE

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BILATERAL TRIGEMINAL TIC

ITS ASSOCIATION WITH HEREDITY AND DISSEMINATED SCLEROSIS

WILFRED HARRIS, M.D., F.R.C.P.

LONDON, ENGLAND

IN A recent paper¹ I have suggested the use of the terms trigeminal tic and glossopharyngeal tic for the two forms of paroxysmal neuralgia affecting the distribution of these two nerves. In both the type of pain is identical, sudden violent brief paroxysms, often started by the movements of eating, swallowing, or handling the face, with the frequent presence of highly sensitive areas of skin, such as lip, ala nasi, or eyebrow, light touches on which may fire off the painful attacks, and aptly named by Patrick "trigger zones."

The term trigeminal neuralgia may be used in too loose a sense to include a number of varieties of pain affecting the face, such as postherpetic neuralgia, a painful sequel of trigeminal zoster, which is increasingly frequent after the age of 50; migrainous neuralgia; the atypical neuralgias, including sympathetic neuralgia and certain recurrent supra-orbital neuralgias which are certainly not migrainous; neuralgia due to irritation of the nerves at the base, and especially that rare form of flashing pain which is liable to affect sufferers from medullary sclerosis following thrombosis of the posterior inferior cerebellar artery.

Thus there may be said to be many trigeminal neuralgias, and it seems to me eminently desirable to use a definite term to describe the paroxysmal form, in which no organic signs of damage to the nerve can be found, such as motor weakness or sensory loss, and in which the pain is arrested by nerve blocking, either by operative section, or by alcohol injection.

Furthermore, precisely similar neuralgic attacks, both in character of the painful spasms and in their reaction to treatment, as well as in the absence of any evidence of trigeminal lesion, are met with in a certain proportion of cases of chronic spastic paraplegia, mostly disseminated sclerosis. There appears to be a rare group also in which typical trigeminal tic appears as a sequel to the sudden onset of trigeminal neuritis, at an interval of weeks, months or years after the fading of the trigeminal anesthesia caused by the neuritis. I have met with three such cases only, in my experience.¹ The type of pain in these cases may be identical with that of the usual trigeminal neuralgia, and is completely relieved by alcohol injection of the gasserian ganglion. They are thus distinguished from the postherpetic cases and those secondary to medullary thrombosis.

The terms trigeminal tic and glossopharyngeal tic will, I suggest, give definiteness to a type of neuralgia whose clinical history and symptoms are clear cut and uniform to an unusual degree among diseases, but whose pathology is at present obscure and unproven. That it may be impossible always to separate this type from rare cases, such as irritation by basal tumors, is a necessary but unfortunate admission in our present state of clinical experience.

Indeed, Dandy² states: "It is impossible to differentiate by clinical tests those cases in which the tic douloureux is caused by a tumor." Of a total of 250 cases treated in his clinic at Baltimore he found 18 tumors in the posterior fossa as the cause of the neuralgia, and in other cases arterial loops and venous branches crossing the nerve so frequently that he considers that in one-third of his cases of trigeminal neuralgia a gross lesion was responsible for the pain.

This proportion seems to me incredible, in view of the constant relief to pain afforded by gasserian injection. He met with eight bilateral cases, or 3.2 per cent in his series.

Frazier uses different terms, such as major neuralgia and tic douloureux when speaking of the same disease, and it seems to me that in order to avoid misunderstandings, which are easy to slip into among so many forms of neuralgia which affect the face and head, precision of nomenclature is a necessary postulate.

Trigeminal tic and glossopharyngeal tic are therefore, I claim, syndromes and not diseases, but may be caused in various ways, the most common by far being that form with which we are all so familiar, and which I believe to be dependent on some irritative process at the periphery of the nerve endings, acquired from dental, sinus, or tonsillar sepsis. Frazier does not help us to clarify our thoughts when he writes:³ "We are convinced that in tic douloureux, unassociated with organic disease, there is no organic lesion as the etiologic factor." He goes on to suggest that the pain may be due to vasospasm, claiming the paroxysmal character of the pain in support of this thesis. The sudden violence of the neuralgia in many cases, "like a flash of lightning," is in my opinion entirely opposed to vasospasm as a cause, and is surely proof of its nervous origin. Its character indeed may be compared with the lightning pains of tabes dorsalis.

No unbiased analytical mind can possibly accept the view that a neuralgia which is so anatomic in its distribution, and never crossing the midline, except when both sides are separately affected, can be idiopathic and a function of normal tissue. Still less can it be of psychogenic origin; there must be a pathologic cause for it, and all the clinical facts point to its site at the periphery of the nerve endings.

Disseminated Sclerosis.—With regard to the occurrence of trigeminal tic as a complication of disseminated sclerosis, I drew attention to its frequency in 1926⁴ when I had met with 17 examples. Since then many observers have confirmed this, notably H. A. Parker from the Mayo clinic,⁵ and several of

my neurologic colleagues in London have also observed the association. Olivecrona⁶ refers to it as a symptomatic neuralgia. The neuralgia is in every way characteristic of the usual paroxysmal trigeminal neuralgia, in severity and type of pain, trigger zones, and reaction to treatment by alcohol injection or root section. The only point of difference is the greater proportion of bilateral cases, seven out of 41 of spastic paralysis with tic, or 17 per cent in my series. This is not surprising if my view of the pathology of trigeminal tic be accepted, that it is due to a terminal neuritis of dental nerve filaments, though the patient may have been edentulous for years. If in addition there are sclerotic plaques in the medulla adjacent to or invading the spinal roots of the fifth nerves, bilateral trigeminal tic would be much more likely to occur, as in disseminated sclerosis.

Frazier³ states that among over 2,000 cases of trigeminal neuralgia he has never met with a case of disseminated sclerosis. This is to me most surprising, and it is his good luck, or possibly misfortune. I should hesitate to suggest that this was due to any omission to examine the general neurologic condition, because that would account for only a proportion of cases whose disability was not too glaring. Many of my cases have been severely or completely paralyzed. In two of them, both men, neither hand nor foot could be moved, and they lay in bed like mummies, unable to move, and everything had to be done for them by nurses. On the other hand some cases will not mention any weakness of legs until specially asked, when it becomes evident that they have been becoming unsteady on their feet, with difficulty in walking, for perhaps a year or more before the pain commenced, and the plantar reflexes will be found to be extensor in type.

Frazier's proportion of bilateral cases is also much less than mine, 1 per cent as compared to 4.5 per cent, and he disregards my figures because he says they include a number of cases of disseminated sclerosis. The facts are that of my 856 private cases, 39 were cases of bilateral tic, and if the 33 disseminated sclerosis cases with three bilateral neuralgias are withdrawn, that leaves 823 cases, 36 being bilateral, or 4.3 per cent. Moreover, I have no possible doubt that were Frazier to examine a case of disseminated sclerosis suffering from the type of trigeminal neuralgia that all my cases have had, he would at once admit the identity of the neuralgia in type with that which he and others describe as major trigeminal neuralgia, being paroxysmal, with no detectable anesthesia, and showing trigger zones, and in having the pain started in the usual way by handling the face, or eating, or other movements. They are, moreover, relieved in exactly the same way, and to the same extent, by the operations of nerve or ganglion injection, or root section.

I have notes of 41 cases of chronic spastic paraplegia complicated by trigeminal tic, 33 of which (18 women and 15 men) were seen in private practice, three being bilateral cases. In addition I have notes of eight cases treated in hospital, four of which were bilateral, all being women.

Although the majority of my records of hospital cases of the usual type

of trigeminal tic have not been preserved, I have notes of about 300, which for one reason or another I considered interesting, and among them are probably all the hospital cases of spastic paralysis with neuralgia that I have seen. Of the total of 41 cases in private and hospital, seven had bilateral trigeminal tic, or 17 per cent, six women and one man. Of my 33 cases in private practice, three were bilateral, or 9 per cent. Very rarely did the neuralgia commence before organic signs of spinal cord disease appeared. In

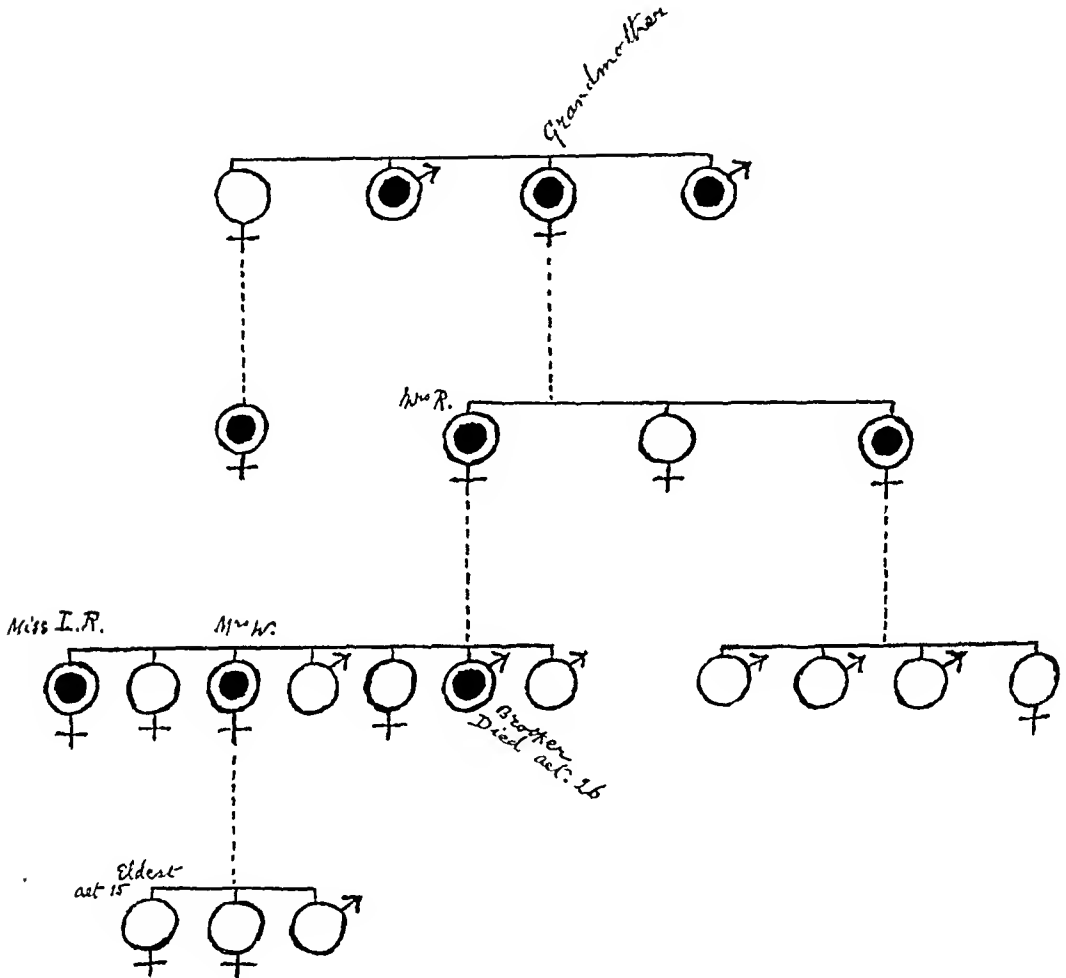


Diagram illustrating heredity of trigeminal tic in the family of my patients, Miss I. R. and Mrs. W. The affected individuals are marked with a black center.

addition to these, in one family the father had trigeminal tic and his daughter developed typical disseminated sclerosis, and in another family I treated the mother for the neuralgia, and her son for disseminated sclerosis. In another I treated the aunt, aged 74, for typical bilateral tic, and her niece for trigeminal tic complicating disseminated sclerosis. The development of the neuralgia in the former lady, aged 74, was interesting. At the age of 44 she had sudden severe pain, beginning in the right upper lip and cheek, coming and going, on and off. Fifteen years later sudden severe neuralgia commenced in the left temple and through the left side of the face, neck and body down to the left foot; similar spasms of pain occurred three times in the same evening,

but never again, except in the left cheek and lower jaw and temple, and half of tongue. The attacks would be started usually by eating, or handling the face, and the pain would occasionally wake her and make her scream. There was a typical trigger zone on the left chin, but the neuralgia on the right side was much less than formerly, mostly prickly pains, like needles, in the right cheek. No injection was considered necessary for the right side, and as she did not want to risk keratitis, in August, 1928, I injected the left second and third divisions separately. This arrested the pain for three years, when I injected her left gasserian ganglion, getting total V.2 and V.3, with analgesia only of V.1, since when there has been no recurrence.

Heredity of Trigeminal Tic.—I have seen in many instances familial heredity of typical trigeminal tic; in one family no less than nine members appeared to have suffered from it, two of them, sisters, being my patients at an interval of 14 years, and both were the subjects of bilateral trigeminal tic. They and their brother all commenced to suffer from the neuralgia between the ages of 16 and 20. He had it only on the right side, and he died at the age of 26 (diagram).

CASE REPORTS

Miss I. R., aged 31, was first seen by me in 1920. Her neuralgia commenced a few months after the age of 16. The first attack of pain was like a flash of lightning in the left lower jaw up to the zygoma. The first and subsequent attacks lasted two to three days, and the crises of pain were precipitated by any movement of the jaw, or sudden noise. In addition she complained of "needle pricks" at the right side of the nose and twitching for several minutes, which were brought on by eating or any facial movements, even occurring spontaneously at times. The pains in the right infra-orbital area alternated with pain in the left lower jaw from the age of 16, though always worse on the left side. She compared the pain to "electric wires."

She was never free of neuralgia for more than a few months at a time, and all her teeth were removed in 1914. She was quite free of all pain between the attacks, the last period continuing for seven months.

February 28, 1920, I injected the left gasserian ganglion by the lateral route, getting temporary anesthesia of V.2 and V.3 for one hour. As the numbness faded, the neuralgia returned, and three days later I again injected through the foramen ovale, getting total trigeminal anesthesia, motor palsy and loss of taste. No further neuralgia has since recurred on the left side. I saw her again in August, 1921, for recurrence of similar neuralgia on the right side, and found the trigeminal anesthesia of the left side was still total except for return of deep sensibility on the eyeball, with partial recovery of the masseter and temporal muscles.

I then injected the right second division of the fifth at the foramen rotundum, getting total right second division anesthesia including pressure, on cheek and upper lip, and on the gum of the upper jaw and palate as far back as the base of the uvula. Two years later the neuralgia attacked the right lower jaw, in August, 1923, becoming severe after a few weeks. In February, 1925, I injected the right gasserian ganglion, getting moderately dense anesthesia of the right second and third divisions. I did not see her again for seven years, when I wrote for her to come and see me. There was still partial anesthesia of the right second and third divisions, and only occasional twitches of pain in the right eye and nose. The left side remained anesthetic as before, but she said she never noticed the numbness there. In August, 1933, the pain returned in the right first and second divisions, and very little anesthesia now remained. I then injected the right

ganglion by the anterior route, getting total trigeminal anesthesia. She was quite free of pain, but unable to bite at all. She wrote that she was not worrying about that. "I am only too glad to be out of pain."

In May, 1935, she wrote, in reply to an inquiry: "My face is still all right. It is quite numb, especially the forehead, nose and lips. The right eye is all right in appearance, but there is always a tingling feeling in it, which makes it not so comfortable as the left side, still I get used to it, and don't mind in the least. I can bite and chew an apple. I was quite a long time before I could eat, and used to get rather downhearted, but after about six months' practice in front of a mirror, I gradually got on and now manage quite well, and I am ever grateful to you for making life worth living for me."

Her long difficulty in learning to eat when bilaterally anesthetic was evidently due to the anesthesia and not to motor weakness.

In giving me the details of her family, she writes: "I know that in all cases the pain has been the same as mine. I had seen my grandmother in terrible agony, although I was only a small child, but I could never forget it."

Her sister, Mrs. W., five years younger, was brought to me in May, 1933. Like her sister, her neuralgia started suddenly with violent pain at the age of 17, in the right cheek and side of nose. This pain recurred frequently, being caused by eating, or handling the face, or by a cold wind. Sometimes the pain shot up through the forehead to the vertex, so severely she might scream aloud.

In 1929 she was injected by another physician, without benefit. Soon afterwards, the neuralgia attacked the left lower jaw, and then the left cheek and nose, 20 years after it began on the right side. She refused to have the ganglion injected, so I injected the right second division only, at the foramen rotundum, getting total anesthesia of cheek, lip and palate on the right side. I hear that she now has pain again, but I do not know which side is troubling her most at present.

I have given the notes of these cases in considerable detail, as they are examples of:

- (1) A family with a strong hereditary taint of typical neuralgic tic.
- (2) The early commencement of the neuralgia in the two sisters and brother at the age of 16 to 20.
- (3) The bilateral affection of the disease in two of these three members of the third generation.

As is also seen in some hereditary mental diseases, the onset of the disorder seems to occur earlier in the descending generation, commencing at 43 in the grandmother, at 32 and 40 in the mother and aunt, and at 16 to 20 in the next generation.

In addition to this family with nine sufferers from the disease in three generations, I have notes of nine other families in which one parent, father or mother, had suffered from similar neuralgia, and in another two instances one grandparent only. In all but one, in which I was able to get approximate dates, the same tendency to anticipation in the younger generation was found. Thus, a lady whom I treated at the age of 62 had begun to suffer at the age of 44. Her father had suffered similarly from the age of 60 until he was 80, when the severe pains left him, and he lived in comparative comfort until the age of 101. This is the only instance I have met with in which the pains disappeared spontaneously without any injection or operative treatment. In

another instance the mother commenced at 68 and the neuralgia lasted until her death at 76, while her daughter, my patient, began to have neuralgia at 41.

In three families I have treated both parent and child by alcohol injection. In 1912 I first injected Mrs. M. who had suffered for 16 years since she was aged 54. She later developed bilateral trigeminal tic, which continued until both gasserian ganglia had been injected. Her second daughter began to suffer in 1913 from neuralgia of R.V.3 at the age of 33, passing off after a few weeks, and recurring severely after 18 months. No treatment arrested this until in 1916 I injected R.V.3 at the foramen ovale. This gave complete relief for over five years, when there was recurrence for a month, then free for 18 months. I then, in 1923, injected the right ganglion, getting nearly total anesthesia, since when there has been no recurrence.

A man who commenced neuralgia between 60 and 70 in R.V.2 I injected five times in seven years at the foramen rotundum. After the last injection in 1924 at the age of 81, he had no recurrence of the pain when still living at the age of 89. His son commenced typical tic at the age of 50, also in R.V.2. He described his pain as originating like little electric shocks in the right cheek, which gradually increased in range and severity, the pain being hot in character, "like forked lightning," and started by movements of eating and talking, or a draught of air. A somewhat unusual character of the pain in his case was that it would often wake him as many as twenty times in a night, making him scream out. Removal of all his teeth had given no benefit. Injection of R.V.2 gave relief for a year in 1921, and in 1923 I injected the right gasserian ganglion, getting total anesthesia of the first division and less complete of the second and third divisions. He had no pain for nine years, until 1932, when pain recurred in the right cheek. He was still totally anesthetic on the first division, the eye and cornea having kept in normal condition, but there was complete return of sensation on V.2 and 3. Reinjection again arrested the pain.

In 1913 I injected the right ganglion in a woman aged 55, who began to suffer in the right upper and lower jaws nine years before, at the age of 46. Total trigeminal anesthesia was produced, and persisted, and seven years later there had been no recurrence. Her son then came to me for similar neuralgia in the left second division which had persisted for four years since he was aged 34. I injected his left gasserian ganglion, getting total anesthesia, which persisted unaltered a week later, and he was quite fit and well. I have had no news of him since.

I have already referred to an instance of a lady aged 74 whom I saw in 1928 with bilateral trigeminal tic, which commenced on the right side at the age of 44, and 15 years later attacked the left side more severely, after which the right side did not trouble her much. Her niece commenced to suffer from left trigeminal tic at the age of 37, which I treated 18 years later. Meanwhile, four years after the neuralgia commenced, her niece began to develop symptoms of disseminated sclerosis commencing with weak legs, and two years later retrobulbar neuritis, with central scotoma, later clumsiness of hands

and sphincter weakness. On examination she had typical disseminated sclerosis, and there could be no possible doubt that her trigeminal tic was indistinguishable from the ordinary variety, and, like them, it was arrested by alcohol injection.

Percentages for Sex and Side Affected.—In studying my statistics of trigeminal tic, two points have constantly struck my notice, the greater frequency of the disease on the right side, and the greater proportion of female sufferers. Of 856 cases seen in private practice, 39 were bilateral, and of the remaining 817 there were 491 right sided to 326 on the left side. Of this total, 550 were women and 306 men. By including 284 hospital cases of which I have notes, my total figures are 1,140 cases, of which 61 per cent were right side and 39 per cent left side. Seven hundred and forty-eight were women and 392 men, or nearly 66 per cent female to 34 per cent male. I have notes of 60 cases of bilateral trigeminal tic, 39 in my private practice, and 21 at my two hospitals, the private cases being equivalent to over 4.5 per cent of my total 856. Of these 60 bilateral cases, the numbers of women were 31 and 17 in the two groups, a total of 48, or 80 per cent, of all the bilateral cases. Frazier's figures, 19 women in 23 bilateral cases, shows the same preponderance in the female. Thus the greater liability of the female to trigeminal tic is, as one would naturally infer, augmented when the disease becomes bilateral, from a two to one to a four to one proportion.

Treatment of Bilateral Trigeminal Tic.—A few of my cases were bilateral from or near the commencement, but in the majority there was an interval of many years between the onset on the two sides, and when both sides were affected, one is usually much worse than the other until the first has been cured by operation or injection. In my experience alcohol injection of the ganglion on each side for bilateral trigeminal tic has been very satisfactory, even though in two of the cases I had to inject both sides at the same sitting, on account of the pain on both sides. It is true that jaw drop then results, and it will be about three months before sufficient biting power is regained. Nutrition can be easily maintained with soft and liquid foods. Owing to the motor root of the trigeminal nerve deriving its nuclear supply from within the pons, the motor fibers regenerate after alcohol injection, even though the sensory nerve cells in the ganglion are completely destroyed and the resultant anesthesia is permanent. If six months or more intervene between injection of the two sides, then rarely is there any real disability in eating, except on account of the bilateral numbness. In some people this may necessitate practice in front of a mirror, as in my hereditary case previously described.

Repeated injection of the foramen ovale may be followed by permanent motor weakness, and if this is done several times bilaterally, it is conceivable that permanent jaw drop might result. I have, however, never yet met with this sequel.

Three years ago I had to deal with an old lady of 88, with severe bilateral neuralgia of the third division, and I injected both foramina ovale on succeeding days. After the second injection she was free of all pain, but com-

plained much of the numbness, as very old women sometimes do, when the pain has vanished. This is, I think, due to failing memory. For some months she was in trouble with jaw drop and had to be fed on minced and soft foods, but later recovered her bite and her pleasure in life, as the following letter recently received from her daughter testifies: "The operation was certainly a very great success, and she has had no return of that terrible pain, which had grown to be almost unbearable. Her mouth has never quite regained its full use, though I think the little disability that remains is largely due to her age and her needing new teeth, which she won't have, because at her age, 91, she is too old, she says." Would a neurologic surgeon have undertaken a bilateral fractional root resection at her age, 88, and with as good a result?

One more bilateral case may be cited as a successful example of ganglion destruction by injection on both sides.

Mrs. M. H. commenced to suffer with neuralgia in the right second and third divisions of the fifth nerve at the age of 36. She used to rub the face to stop the pain, and rubbed away half her right eyebrow. Seven years later, in February, 1913, I injected the right gasserian ganglion, producing permanent total trigeminal anesthesia, unaltered after five years, when the right masseter was found to have recovered completely. Neuralgia commenced in the left second division in July, 1918, with trigger zone on lower lip. The left second division was injected, with total second division anesthesia. She had freedom from pain for 16 months, when all anesthesia on the left side had faded away. I then did a left ganglion injection, obtaining total anesthesia. The left masseter was weak, but no obvious loss of biting power. She then had bilateral total trigeminal anesthesia. Later she described that her food felt like chaff in her mouth, that she could not feel or taste it until she began to swallow. She also mentioned that she could not feel herself kiss her husband. In spite of this additional handicap, she declared the cure of the pain was worth it ten times over.

Character of the Pain.—It is remarkable how often the type of pain is complained of as being hot. Thus it may be compared to "red hot wires" or "fishhooks," "electricity," "like 500 needles shot into the face," or "like a bunch of fireworks exploding." The suddenness of onset and cessation of the pain is characteristic, though after it has passed there is often left behind a sensation of burning in the face for a short time. In the most typical forms all movements such as eating, blowing the nose, cleaning the teeth, washing or rubbing, especially very light touches on the cheek, or a draught of air, will start a painful spasm, but in some of the cases eating has no bad effect, though handling the face may always start an attack during a period of suffering. Some few cases instinctively rub the face to check the pain, and occasionally an eyebrow or mustache may be rubbed away by this constant maneuver, and I have seen the skin of the face on the affected side quite calloused and thickened, so that the two profiles appeared like different people. Sometimes while the pains are recurring regularly there may be apparently hypo-esthesia to pin prick on the cheek and lips, which may lead to a suspicion of an organic lesion, though the sensation will be found to be equal and normal when the bout of attacks has subsided. More commonly, while the painful

attacks are going on, the cheek is more sensitive to pin prick on the affected side.

Sometimes the painful spasms recur at almost regular intervals of three to three and one-half minutes. One such case that was sent to me could not restrain himself from throwing up his hands and holding them or his pillow tightly on to his face as soon as the pain attacked him. An attempt had been made at another hospital to inject him, but had failed for this reason. I asked him if he could give me a second's warning before doing this, which he promised to do, so having got everything ready, and the landmarks drawn on his face and painted over with iodine in spirit, I waited until a paroxysm ceased, and then immediately novocained the skin and deeper parts and quickly sank a $2\frac{3}{4}$ inch needle by the lateral route to his foramen ovale, and was successful in anesthetising the nerve with novocain, and thus arresting the next spasm before it became due. After that the alcohol injection was proceeded with slowly, as usual. Another case of a young phlegmatic Scot had been sent to me from Burmah, and was having spasms of pain every one to one and one-half minutes for weeks, night and day. He had had practically no sleep and was brought straight from the ship to the nursing home. The spasms of pain continued up to the moment of my finding the foramen ovale with the needle; fortunately he was able to keep his hands and head fairly still, or a general anesthetic would have been necessary, such as morphia-hyoscine, or avertin. Evipal is, I think, less suitable.

Methods of Injection.—In the large majority of cases local novocain is sufficient and far the best, if time is taken and nothing hurried. The patient's cooperation is most valuable in getting the best results, as their replies to repeated tests with a pin are essential for a perfect approach to the hole, to use a golfing phrase. No alcohol should be injected until anesthesia of the chin and lower lip have been obtained with novocain (2 per cent). Then slowly, drop by drop, 90 per cent alcohol is injected, never as much as 0.5 cc. pushed in quickly, or trouble may result. Total ganglion anesthesia often results after the first four or five minims, but although this is most encouraging, we must not be deceived into believing that the operation is concluded, and withdraw the needle. Often far from it. Patience is necessary, and we must wait, perhaps ten minutes, before repeated tests disclose the fact that sensation is returning on forehead and cheek. Such anesthesia is due to ganglion shock, the nerve cells being, so to speak, knocked out temporarily like a boxer by a blow on the chin. Slowly, drop by drop, more alcohol is injected, and if the point of the needle is truly placed, then again total anesthesia is obtained, and the same sequence of events may recur three or four times before the anesthesia persists. Even then it may be found that next day partial sensation has returned. Occasionally permanent and total anesthesia results from the first injection of as little as five or six minims of alcohol (0.3 cc.). Care must, of course, be taken before injecting any alcohol, to see that no C.S.F. drips from the needle, or the alcohol will seep round to the internal auditory meatus, causing intense vertigo and nausea, nystagmus to the opposite side, and perhaps even nerve deafness and facial palsy. This I

usually speak of as the vestibular syndrome. The same result may follow too rapid injection into the ganglion tissue, causing it to burst, with leakage of alcohol along the base.

Immense patience is essential for successful alcohol injection of the ganglion, often one and one-half to two hours being necessary to produce the best result. If done in this manner, I consider it is superior to any operative root section, as all danger to life or to the effects of cerebral compression are avoided. I agree entirely with Härtel⁷ that it is not the mild atypical neuralgias that should be injected, but the fierce unbearable trigeminal tics. "Nein und nimmermehr! Nicht die 'Minorfälle' sondern die 'Maximurfälle' gehören der Ganglioninjection."

His figures are instructive. Of 73 German cases he obtained total anesthesia in 47, or 64.5 per cent, and 68.5 per cent remained cured. Of 98 Japanese cases he obtained total anesthesia in 62 per cent and cure in 81 per cent, with return of pain in only 19 per cent. His statistics agree approximately with mine in showing a relative high proportion of right sided cases, 63 per cent to 37 per cent on the left side. He had, however, more male than female cases, out of a total of 213, which differs strikingly from my experience.

Motor paralysis usually passes off gradually after a lapse of three months, and bilateral ganglion destruction by alcohol injection is compatible with good power of eating and chewing, as I have proved many times. Both sides may even be injected at the same sitting in the emergency of severe bilateral neuralgia, for temporary jaw drop of a few months is not to be compared with the agony of persistent painful spasms.

Injection of Inner Two-Thirds of Ganglion.—In many cases of violent neuralgia affecting the first and second divisions only, I have been able to leave good sensation in the lower jaw and tongue, and yet produce total and permanent anesthesia of the upper portion of the face. This I do by pushing my needle one-quarter inch farther through the foramen ovale before injecting any alcohol, and after anesthetizing the third division with novocain. The preservation of sensation on the lower jaw and tongue is valuable in such patients for purposes of eating and enjoying their food, as if these parts are anesthetic they invariably choose to eat on the other side, just as they do when suffering from neuralgia.

Formerly I invariably used the lateral route to reach the foramen ovale, between the zygoma and the sigmoid notch, but during the last three years I have used mainly the anterior route which Härtel described, when I wish to inject the ganglion. Owing to its steeper approach, there is greater ease in many cases in passing the needle between the lips of the foramen, but a four inch needle is required instead of one of two and three-quarter inches. If the route is first well prepared with novocain with a fine needle, I do not find much greater risk of hematoma than by the lateral route, and it is always easily controlled.

Sometimes I fail to get good ganglion anesthesia by the anterior route, and then may succeed perfectly by the lateral route, and it is certainly very useful to have an alternative approach. This greatly increases the proportion

of cases in which dense and permanent ganglion anesthesia is obtainable, so that very rarely should failure result. Even an open operation by a neurologic surgeon sometimes fails to section the nerve as desired.

Frazier has greatly advanced the technic of the open surgical operation by his perfection of the fractional root section method and saving the motor root, and it would appear from his statements that he does not admit recurrences of neuralgia. By Dandy's cerebellar route a useful alternative approach is afforded, which probably offers greater security for the motor root. Dandy, however, in his subtotal series, confesses to four recurrences, and judging from Hutchinson's and other partial gasserectomies, in which recurrence of the neuralgia is not uncommon, I feel convinced that to ensure absolute safety of nonrecurrence a total root section or ganglion destruction is necessary. In the small proportion of cases in which the ophthalmic branch is definitely involved together with the second division, it would be most unsafe to leave the inner portion of the root undivided, in order to minimize the risk of keratitis, for a second gasserian operation is a very serious risk. On the other hand, injection of the inner portion of the ganglion, leaving the third division sensitive, is a negligible risk in case neuralgia spreads into the lower jaw or tongue, for the injection can be easily repeated, and the third division and outer portion of the ganglion dealt with as if it were a fresh case.

All gasserian operations are difficult, and require highly skilled neurosurgery, and should never be trusted to a surgeon who has not studied and practiced the operation carefully. Much the same may be said of alcohol injection. Long practice and familiarity with the anatomy and the methods of injection and its difficulties are necessary to produce the best results, and should, therefore, be left to the hands of experts, and here again I may quote Härtel⁸: "Nicht nur die Ganglionoperation, auch die Ganglioninjection gehört in Meisterhände." Unfortunately, many surgeons attempt it without due study, owing to its comparative safety, and consequently fail, and even sometimes make tragic blunders. Thus alcohol injection is often looked upon askance and rejected by physicians and surgeons as at best only a temporary palliative, but it is, when properly performed, one of the most delicate and beautiful operations in minor surgery, equally capable with the open operation in effecting a permanent cure, and with no risk to life.

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PENETRATING WOUNDS OF THE BRAIN

AN EXPERIMENTAL STUDY

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THE extremely variable tolerance of the brain for foreign bodies introduced through penetrating wounds of the skull has led to a wide diversity of opinion regarding their treatment. Many cases of prolonged retention of foreign bodies without symptoms are on record. Elliot's¹¹⁰ patient was known to have had a bullet in his brain for 65 years without symptoms, and other cases have survived 30 years (Martin¹²¹), 27 years (Tanaka¹³³), 18 years (McLean²⁰⁴), piece of steel; Schlöss,¹⁷⁵ knife blade, 17 years; (McEachern²⁰³), surgical probe; and similar periods.

On the other hand, latent brain abscesses have made their appearance after 16 years (Urechia¹⁶⁵), 11 years (Bregman¹⁵⁵), 10 years (Ransohoff¹⁶⁴), and lesser intervals; and innumerable cases of late epilepsy are reported.

By far the most common foreign bodies lodged in the brain have been bullets and the voluminous literature of the various periods of war has abounded in reports and discussions on the subject. However, in less frequent instances the brain has been penetrated by almost every other conceivable instrument. Of these, knife blades are the most common (Babcock,¹⁶⁷ Blaine,¹⁶⁸ Brown and Birch,¹⁶⁹ Dretzka,¹⁷⁰ Guleke,¹⁷¹ Karschulin,¹⁷² Pepper,¹⁷³ Schloffer,¹⁷⁴ Schlöss,¹⁷⁵ Selwyn,¹⁷⁶ Slee,¹⁷⁷ Sommer,¹⁷⁸ Wilkins¹⁷⁹) and cases have been reported of penetration of the brain by pitchfork prongs (Kesteven,¹⁹⁸ Hooper¹⁹⁵), a crochet hook (Franklin¹⁹¹), a knitting needle (Annandale¹⁸¹), breech-pins (Cunningham,¹⁸⁵ Thompson,²¹¹ Kemper,¹⁹⁶ Burr,¹⁸⁴ Noyes²⁰⁵), surgical instruments (McLean,²⁰⁴ McEachern²⁰³), pieces of wood (Pridioux,²⁰⁷ Matthews,²⁰² Ferguson,¹⁸⁹ Key and McCrummen¹⁹⁹), the rib of an umbrella (Donkin¹⁸⁶), a crow-bar (Harlow^{194, 183}), iron rods (Swanson,²⁰⁹ Pugh²⁰⁸), nails (Levin,²⁰⁰ Felty¹⁸⁸), and other bizarre objects.

In the first half of the last century, most surgeons adhered to the conservative advice of Sir Benjamin Brodie¹⁴ (1828), who stated that no foreign body should be removed unless it lay on the surface of the brain in an already open wound. By the middle of the century, some surgeons had begun to remove foreign bodies in some instances. In the "Medical and Surgical History of the War of the Rebellion"⁸⁶ are reported 85 cases of bullet removal, of which 43 are listed as "recoveries." In 1868, Andrews³ reviewed 73 cases of retained bullet and advocated removal ("and the sooner the better") of all superficial foreign bodies which could be definitely located and easily approached. Ten years later, the same opinion was expressed by Wharton⁸⁸ who collected 316 cases. Of these, the foreign body was removed in 106 cases

with 72 recoveries and not removed in 210 cases with only 88 recoveries. Similar opinions were expressed by Morris⁵⁵ (1887), and Papaillon⁶¹ (1894). Hewett and Lidell⁴⁰ stated (1881): "Every reasonable effort should be made to extract foreign bodies when lodged in the brain."

With the discovery of roentgen rays (first employed for the location of cranial and intracranial foreign bodies in 1896 by Stubenbord²¹² of New York, Eulenberg²¹³ and Schier²¹⁴ of Berlin, and Fowler²¹⁵ of Brooklyn, in the order named), the removal of many more foreign bodies was attempted. Indeed, Phelps¹²⁶ wrote, "There is probably no authenticated case . . . in which the bullet left in the brain substance has failed to work mischief," and in 1910 Da Costa²¹ stated, "Practically every lodged bullet (in the brain) constitutes a fatal condition and it should be removed if possible, even if there are no symptoms."

With the beginning of the World War, another controversy further complicated the situation. Prior to this time, the commonly accepted method of treatment of penetrating wounds of the brain had consisted in removal of fractured bone, leaving the wound, including the dura mater, open, allowing a cerebral hernia to develop and the wound to heal (if it would) by secondary intention (von Bergmann,¹¹ Papaillon,⁶¹ Doyot²⁶). This method was advocated again during the war (Whitaker,⁸⁰ Moulouguet and Legraine,⁵⁰ Hunt⁴⁵), but was condemned by Bárány,^{8, 9} Cushing,^{18, 19, 20} Willems⁹⁰ and many others, who advocated early operation, complete débridement and primary suture.

The diversity of opinion continued throughout the war, both as regards foreign bodies and the open and closed methods of treatment. Gross and Houdard³⁴ advocated primary suture of wounds without removal of foreign bodies. Sargent and Holmes^{68, 69} stated that only readily accessible foreign bodies should be removed. On the other hand Dretzka,²⁵ Tilmann,⁷⁷ Mathieu,⁵³ Anderson¹ and others advised primary suture after removal of all foreign bodies. Moulouguet and Legraine⁵⁶ thought all foreign bodies should be removed and the wound left open. In 1918, Cushing^{19, 20} advanced the rational doctrine that foreign bodies should be removed whenever the damage of removal did not exceed the trauma of the original penetration. He devised the catheter-suction method of débridement and employed the "tripod" or "Isle-of-Man" incisions with primary suture in all cases. These principles were widely accepted (Horrox,⁴² Neuhoff,⁵⁹ Harvey,³⁸ Willems⁹⁰).

Many special methods came to be employed. Localizing and extraction apparatus was designed by Hirtz,²⁴⁶ Ferguson,²⁴⁵ Banzet,²⁴⁴ and Swanberg,²⁴⁸ electromagnets were employed by Lee,²³⁸ Cords,²³⁴ Lefort,²³⁹ Cushing,²³⁵ Sargent and Holmes,²⁴² La Peyre,²³⁷ Mauclair,²⁴⁰ Spick and Jauréginberry,²⁴³ Kümmell²³⁶ and Regard,²⁴¹ and extraction under the fluoroscopic screen was advocated by Cazamian,²²⁷ La Peyre,²²⁹ Rouvillois,²³³ Lee²³⁰ and others.*

* In 1903, Holzkmnecht²²¹ anticipated the fluoroscope by making plate exposures at operation to determine the location of a previously inserted probe in relation to the foreign body.

De Martel⁵² was the first to advocate the use of local anesthesia, which was widely employed thereafter.

Concerning the late treatment of retained foreign bodies, it was generally agreed that only those which were very superficial or those which were causing symptoms should be removed (Bagley,⁹² Coleman,¹⁰³ Frazier and Ingham,¹¹² Demmer,¹⁰⁶ von Eiselsberg¹⁰⁹). This was finally expressed as the official opinion of the Interallied Surgical Conference.¹¹⁶

That the diversity of opinion alluded to above exists is ample evidence that the factors underlying the tolerance of the brain for foreign bodies are poorly understood. On only one of these factors is there unanimity of opinion: all observers agree that penetration of the cerebral ventricles by a foreign body greatly increases the danger of fatal infection (Harvey,¹⁴² Cushing,¹³⁸ Trotter and Wagstaffe,¹⁵² Regard,^{150, 151} Horrax¹⁴⁴ and others). Other factors, such as the duration of retention, and communication with the subarachnoid space or surface of the skin, have been generally ignored or disagreed upon.

Experimental work on the subject has been meager. In 1862, Flourens²⁵⁰ placed "leaden bullets" upon the surface of the brains of rabbits and dogs and observed that the presence of a foreign body seemed to predispose to "inflammatory action." In 1869, Philipeaux and Vulpian²⁵⁴ produced wounds in the left hemispheres of three dogs and observed that two died, while one recovered. Kramer and Horsley²⁵¹ studied the immediate effects of gunshot wounds on the circulation and respiration. Hortega and Penfield,²⁵⁵ and Penfield and Buckley,²⁵² have made careful studies of the histology of experimental cerebral wounds.

The present report is concerned with a study of some of the various factors influencing the outcome of penetrating wounds of the brain.

METHODS.—Dogs weighing from five to eight kilograms were used in all experiments. Experiments were of two general types: those in which a short, sharp nail about two millimeters in diameter was inserted through the skull to varying depths and left in place for varying lengths of time and those in which a lead air rifle shot (about two millimeters in diameter) was introduced into the brain through a small operative opening in the skull. In the former series, the animals were given morphia 0.13 Gm. (1½ gr.) one-half hour previously; in the latter they were anesthetized with ether.

The nails used were filed until very sharp and, with the animal's head firmly held on a wooden block, surprisingly little force was required to pierce the skull to any desired depth. Once through the skull, the nails were held firmly by the bone and could not be withdrawn without the use of a claw hammer or other instrument. After a period of two to four days, pressure necrosis (and, in some instances, infection) of the bone had occurred to a sufficient extent to render the nails loose and, in several instances, they came out spontaneously. In no instance was a fracture produced. Subsequent to the original procedure, all animals were observed frequently. In several

instances in which obviously fulminating infections developed and at the end of varying periods in surviving animals, they were painlessly sacrificed.

The same site was chosen in all animals for placing the nail or making the opening through which the shot was to be inserted. This was a point approximately 2 cm. above the posterior point of attachment of the left ear to the scalp. This point corresponds to a "silent" area of the brain and in no instance were any abnormal neurologic signs demonstrable immediately after the insertion of the foreign body.

Clinical neurologic signs are extremely difficult to evaluate in the dog. Only those which were quite definite will be mentioned in this report.

The nails and shot were not sterilized nor were they deliberately contaminated with any particular organism. Detailed bacteriologic studies were not made, but, in several instances in which cultures were made from widespread cerebral infections mixed growths of staphylococci, streptococci and *Bacillus coli* were obtained.

RESULTS.—*Group I.*—In 12 dogs, nails were inserted to a depth sufficiently great to penetrate the lateral ventricle and allowed to remain in place throughout the animals' lives. Approximately 1 cm. of the nail was left protruding from the scalp. The results are given in Table I.

TABLE I

The Effect of a Foreign Body Penetrating and Left Indefinitely in Communication with the Skin Surface

Dog No.	Duration of Life in Days	Ventricle Penetrated	Blood in Frontal Sinus	Postmortem Findings
N 1	2	Yes	Yes	Left ventricle distended with pus. Extensive left sided meningitis
N 2	2	Yes	Yes	Left ventricle distended with pus. Extensive left sided meningitis
N 3	2	Yes	Yes	Left ventricle distended with pus. Extensive left sided meningitis
N 4	1	Yes	No	Large hemorrhage in left ventricle. Clot in posterior fossa
N 5	2	Yes	Yes	Both lateral ventricles full of pus. Purulent meningitis on left
N 6	2	Yes	No	Pus-filled nail tract and ventricle on left. Left sided meningitis
N 7	14*	Yes	No	(1) Extensive osteomyelitis. (2) Dura adherent over left hemisphere. (3) Puncture wound sealed off. (4) Ventricular system distended pus
N 8	26†	Yes	No	Chronic healing meningitis; chronic inflammation and necrosis extending to ventricle and involving choroid plexus. Multiple microscopic abscesses in adjacent area

TABLE I—*Continued*

N 9	6	Yes	Yes	Ventricular system full of pus. Widespread meningitis
N 10	3	No	No	Large left sided subdural abscess, extending to floor of middle fossa
N 11	3	Yes	No	Dura adherent at puncture site. Extensive ependymitis in lateral ventricles; gross pus in third and fourth ventricles and about brain stem
N 12	2	Yes	No	Adhesions over left hemisphere. Pus in left lateral, third and fourth ventricles and about the base; ependymitis in right lateral ventricle

* Nail came out spontaneously on sixth day. Animal died on fourteenth day.

† Nail came out spontaneously on fifth day. Animal sacrificed on twenty-sixth day.

One dog (N 4) died on the day on which the nail was inserted and was found to have a large intraventricular hemorrhage. Six dogs died on the second day, two on the third day and one on the sixth day after insertion of the nail. In eight of these nine animals, the nails were found to have penetrated the ventricles, and a widespread ventricular, cerebral, and meningeal infection was present. In six of these animals, the ventricles were distended with pus. In the ninth animal (N 10) who died on the third day, the nail had not penetrated the ventricle and the necropsy revealed a large subdural abscess.

Clinically, the signs in these nine animals were those of overwhelming infection and general impairment of the function of the central nervous system. Lethargy, rapidly progressing to stupor, coma and death, was present in all. Hemiplegia was apparently complete in Dog N 10 shortly before death. None of the animals had definite choking of the optic disks.

In one dog (N 7), the nail came out spontaneously on the sixth day. The animal ate well, was quite active and there were no apparent symptoms until the twelfth day when he became drowsy, refused food and grew rapidly worse. He died on the fourteenth day. During these two days, he developed high choking of the disks. At necropsy, the ventricular system was full of pus, but the puncture wound in the cortex was sealed off and apparently the outlet from the fourth ventricle was also obstructed, for no inflammation was found in the meninges.

In the single remaining experiment in this group (N 8), the animal was very ill for five days. He was apathetic, staggered and tended to fall to the right. The optic disks became hyperemic and their edges blurred. Pus exuded around the nail. On the fifth day, the nail came out spontaneously, and following this the dog slowly improved until, on the twenty-first day, he was entirely free of symptoms, ate well, and was quite active. The scalp wound had gradually ceased to discharge and was healed. The dog was sacrificed on the twenty-sixth day. Necropsy showed dense adhesions of the thickened dura and arachnoid and a walled off, chronically inflamed tract extending into the ventricle. Microscopically, the choroid plexus was found bound up in the chronic inflammatory process and there were numerous small adjacent abscesses, several of them containing fragments of bone. Compound granular corpuscles filled with phagocytized material were numerous and an area of gliosis extended well into the surrounding cerebral tissue.

In five of these dogs, there was terminal bleeding from the nose and at necropsy the frontal sinuses were found filled with blood. The cause of this is not clear and it is mentioned here as an incidental finding.

Comment.—It was apparent from these experiments that a number of factors might play a part in the development, severity and extent of the infections produced. Among these were the duration of retention of the foreign body, depth of penetration, and communication with skin, sub-arachnoid space and ventricle. Subsequent groups of experiments were designed to demonstrate the importance of these factors.

Group II.—In 12 dogs, nails were inserted as in Group I, but were removed at the end of 24 hours in four dogs, 12 hours in four dogs and immediately after insertion in the remaining four dogs. The results are given in Table II. In three of the four dogs retaining the nail for 24 hours, death occurred in four, two and three days, respectively. In two of these, the ventricle was penetrated, but in one of them (N 15), the infection found at necropsy did not involve the ventricle.

TABLE II

The Effect of a Deeply Penetrating Foreign Body Left in Communication with the Skin Surface for Twenty-four Hours or Less

Dog No.	Interval Before Removal of Nail, in Hours	Interval Before Death or Sacrifice, in Days	Spontaneous Death or Sacrifice	Ventricle Penetrated	Postmortem Findings
N 13	24	57	Sac.	No	Brain healed. Small cortical scar
N 14	24	4	Sp.d.	No	Small focus of cortical necrosis. No other cause of death found
N 15	24	2	Sp.d.	Yes	Large subdural abscess on left with inflammation in outer portion of nail tract
N 16	24	3	Sp.d.	Yes	Large cortical abscess with involvement of left ventricle
N 25	12	62	Sac.	Yes	Brain healed. Small cortical scar adherent to dura with tiny core extending to ventricle
N 26	12	62	Sac.	No	Brain healed. Superficial cortical scar
N 27	12	3	Sp.d.	Yes	Widespread purulent meningitis, and encephalitis. Left ventricle full of pus
N 28	12	81	Sac.	Yes	Brain healed. Scar tissue core extending to ventricle
N 17	0*	60	Sac.	Yes	Brain healed. Scar tissue core extending to ventricle
N 18	0*	102	Sac.	Yes	Brain healed. Scar tissue core extending to ventricle
N 19	0*	86	Sac.	No	Brain healed. Small cortical scar
N 20	0*	20	Sp.d.	Yes	Died of distemper. Brain healed

* In these animals, the nail was withdrawn immediately after its insertion.

In dog N 14, death occurred on the fourth day, but the necropsy revealed only a small focus of superficial cortical necrosis and the ventricle had not been penetrated.

Dog N 13 recovered and was sacrificed on the fifty-seventh day. The brain was healed and the ventricle had not been penetrated.

Three of the four dogs in whom the nails were left in place for only 12 hours recovered, and, when sacrificed after long intervals, showed no active intracranial infection. In two of the three, the ventricles had been penetrated. The remaining animal (N 27) died on the third day of a fulminating infection involving the ventricle.

All of the four dogs from whose brains the nails were removed immediately after insertion recovered without symptoms at any time and their brains were healed at necropsy. One of them died on the twentieth day of acute distemper. The ventricles had been penetrated in three of the four dogs.

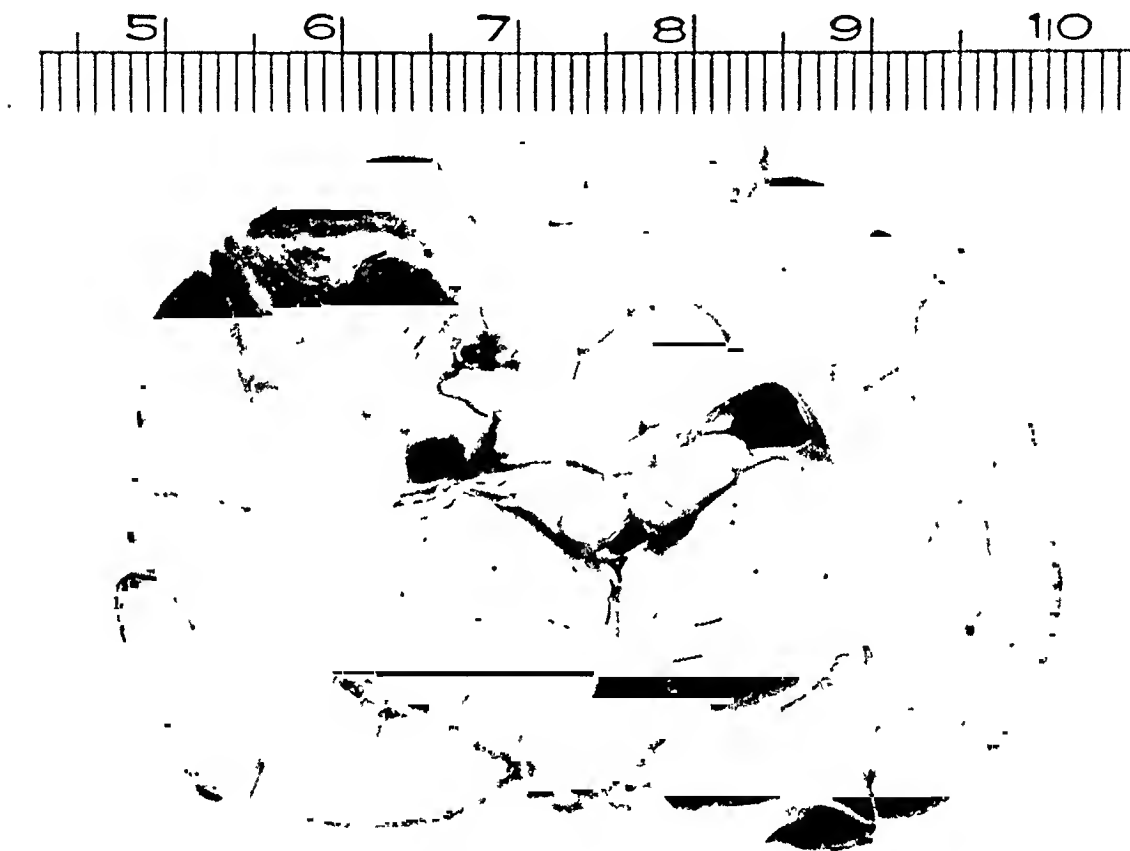


FIG. 1.—Dog N 22. Well walled off abscess 21 days after penetration by foreign body.

Comment.—The experiments in this group showed clearly that the duration of retention of a foreign body communicating with the surface of the skin was a factor of prime importance and that, under these experimental conditions, the period of retention following which recovery was likely was not greater than 12 hours. Sargent⁶⁷ has stated that a delay of two to four days after receipt of the wound is advisable before operation is undertaken. The same opinion was concurred in by Cushing¹⁸ in 1916, but he later apparently believed in earlier operation.^{19, 20} Trotter and Wagstaffe⁵⁰ advocated extraction of foreign bodies within 12 hours if possible. The present experiments are in support of this opinion.

Group III.—In eight experiments, the foreign bodies were inserted as in the preceding groups except that the nails were shorter and the approximate depth of cortical

penetration was 6 to 10 Mm. in four dogs and 2 to 3 Mm. in four dogs. Table III shows the results. In seven of the experiments, the nail came out spontaneously in from two to eight days. Six of the eight animals recovered spontaneously and showed no active infection when sacrificed. One (N 22) died on the twenty-first day and necropsy showed a large, well localized cortical abscess (Fig. 1). The remaining dog (N 32) died of a fulminating infection on the second day. The infection involved the ventricle and it is possible that the latter was penetrated by the nail.

TABLE III

The Effect of a Superficially Penetrating Foreign Body Left in Communication with the Surface of the Skin. Ventricle Not Penetrated

Dog No.	Interval Before Spontaneous Loss of Nail, in Days	Interval Before Death or Sacrifice, in Days	Spontaneous Death or Sacrifice	Approximate Depth of Cortical Penetration, in Mm.	Postmortem Findings
N 21	4	44	Sac.	6-10	Adherent dura. Small cortical scar
N 22	8	21	Sp.d.	6-10	Large, localized cortical abscess. Local osteomyelitis
N 23	4	44	Sac.	6-10	Surface of brain red. Light dural adhesions. Cortical scar
N 24	5	44	Sac.	6-10	Small cortical scar
N 29	3	66	Sac.	2-3	No gross lesion in brain
N 30	4	66	Sac.	2-3	Tiny cortical scar
N 31	2	66	Sac.	2-3	Local dural adhesion to cortical scar
N 32	2	2	Sp.d.	2-3 (?)	Large subdural and cerebral abscess extending into left ventricle

Comment.—It is to be noted that the foreign bodies were retained in all the experiments in this group well beyond the period of safety found in animals whose ventricles had been penetrated (Groups I and II). It is apparent, therefore, that penetration of the ventricle greatly increases the danger of a fatal outcome in such wounds. This is in accord with the clinical opinions already cited.

Group IV.—In eight experiments, the scalp was closed over the nail. In four of them, the head of the nail was left outside the temporal muscle and just beneath the scalp (Table IV). Three of these dogs died of extensive purulent meningitis with cortical infection in three, six and five days, respectively. One of these (N 32) had a large cortical abscess (Fig. 2). In all these, there was purulent exudate and necrosis in the overlying muscle. The fourth dog recovered and at necropsy on the thirty-second day only a small subdural hematoma without meningeal or cortical infection was found. The muscle was densely adherent and fibrosed but was healed.

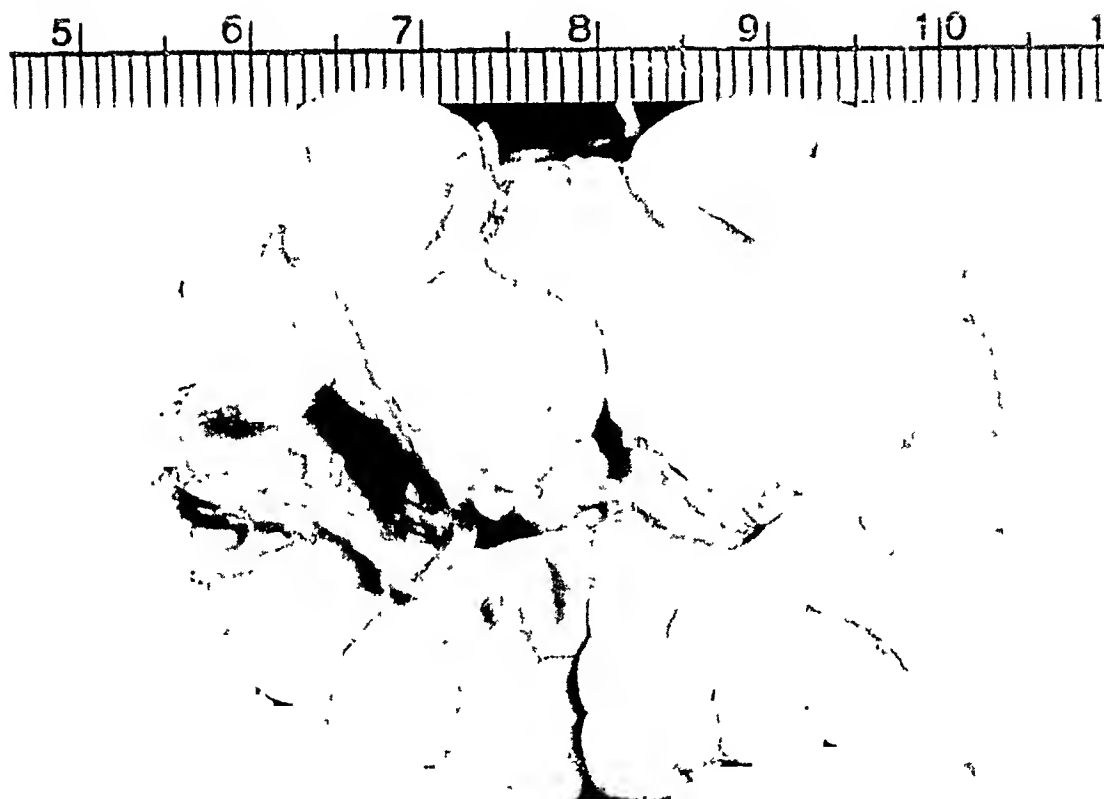


FIG. 2.—Dog N 36. Large necrosing cortical abscess five days after penetration by foreign body.

TABLE IV

The Effect of a Penetrating Foreign Body Over Which the Scalp Has Been Closed

Dog No.	Interval Before Death or Sacrifice, in Days	Spontaneous Death or Sacrifice	Postmortem Findings	Length and Depth of Nail
N 33	3	Sp.d.	Extensive purulent meningitis. Small, shallow cortical abscess	Nail, 1.5 cm long, with head inserted to outer surface of skull
N 34	32	Sae.	Chronic subdural hematoma. No apparent infection about nail	
N 35	6	Sp.d.	Purulent meningitis. Small localized cortical abscess	
N 36	5	Sp.d.	Purulent meningitis. Large localized cortical abscess	
N 37	2	Sp.d.	Small cortical abscess. No gross meningitis	Headless nail inserted through bone
N 38	37	Sp.d.	Well walled off subdural and cortical abscesses	
N 39	74	Sae.	Brain firmly healed about nail. Tip in ventricle	
N 40	74	Sae.	Brain firmly healed about nail	

In the other four dogs, the nails were headless and were inserted completely through the skulls by means of a steel pin with which they were driven. Dog N 37 died on the second day. Necropsy revealed only a small cortical abscess. Dog N 38 died on the thirty-seventh day with a large, well walled off subdural and cortical abscess (Fig. 3A). The other two dogs recovered completely. There was no infection about the nails, although in one of them (N 39) the tip of the nail had penetrated the ventricle (Fig. 3B). The muscle was completely healed in all except N 37. In the three animals in this group who recovered, the nails were completely isolated from the free subarachnoid space by dense dural adhesions.

Comment.—These experiments suggest that communication of a penetrating foreign body with the subarachnoid space considerably increases the danger of fatal infection and that this danger is further augmented if the foreign



FIG. 3.—Headless nails were inserted into the cortex. (A) Dog N 38.—Large subdural and small cortical abscess, thirty-seventh day. (B) Dog N 39.—The brain is healed about the nail. The tip of the nail has penetrated the ventricle, seventy-fourth day.

body protrudes into the soft tissues overlying the skull. Angerer,⁴ in 1914, stated that all patients with wounds penetrating the dura died. This statement is somewhat extravagant, but the danger of communication of foreign bodies with the subarachnoid space has not been generally recognized.

Group V.—In each of eight dogs, an air rifle shot was inserted into the brain through an operative opening in the skull. The operations were performed under aseptic conditions except that no attempt was made to sterilize the shot which were picked up with a fine sterile forceps and inserted into the cortex to the desired depth. The wounds were closed in layers with silk.

In four experiments the shot were inserted to a depth of approximately 10 to 15 Mm. (Table V). All four animals recovered without having developed symptoms at any time. At necropsy, the shot were found firmly bound about with dense fibrous adhesions from which a scar tissue "core" as described by Penfield and Buckley^{2,3} led to the cortical surface (Fig. 4). The ventricle had not been entered in any case.

In the other four experiments, the shot were inserted to a depth of 20 to 30 Mm. Dogs N 52 and N 54 were sacrificed when severe symptoms appeared on the sixth and twentieth days, respectively. In both, the shot had traversed the ventricle and lay deep in the base of the brain. The inflammatory reactions in both were of a chronic nature with organization and fibrosis (Fig. 5). Both showed a low grade basilar meningitis.

TABLE V

The Effect of the Penetration of a Non-protruding Foreign Body Into the Brain

Dog No.	Depth to Which Shot Was Inserted, in Mm.	Period Before Sacrifice, in Days	Postmortem Findings
N 41	10-15	106	Shot embedded in scar with core leading to cortex
N 42	10-15	85	Shot embedded in scar with core leading to cortex
N 43	10-15	254 plus	Still living
N 44	10-15	128	Shot embedded in brain. Thin core leading to cortex
N 51	20-30	50	Scar tissue core marks tract of shot
N 52	20-30	6*	Hemorrhagic, organizing abscess. Mild basilar meningitis
N 53	20-30	92 plus	Still living
N 54	20-30	20*	Small, superficial cortical abscess; tract about shot healing; fibrinopurulent exudate at base

* These animals were sacrificed when severe symptoms appeared.

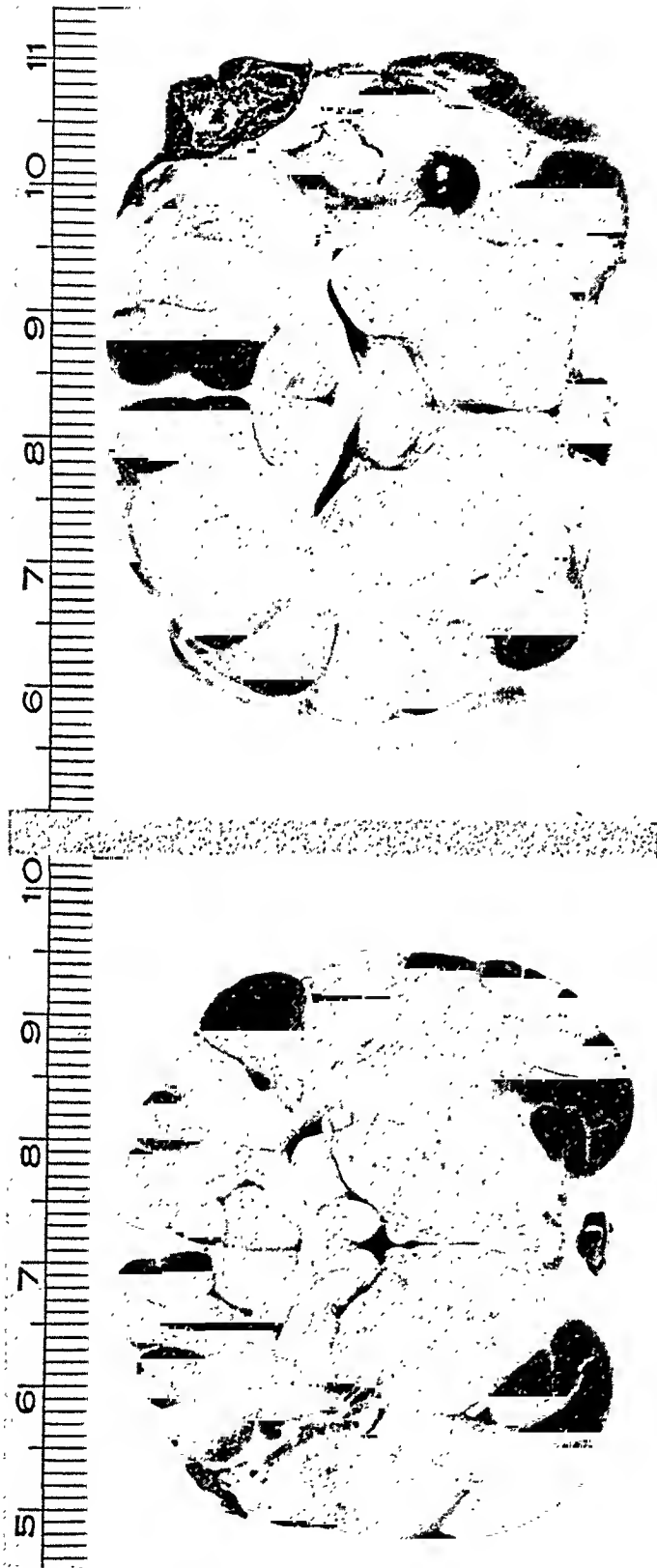
Dogs N 51 and N 53 recovered completely. In the former, the shot was found at the bottom of a healed tract, as in the previous group. Dogs N 43 and N 53 have been preserved alive for histologic study of a more long standing healing process.

Comment.—The uniform recoveries in the first four experiments of this group constitute strong evidence that the high incidence of fatal infection found in the preceding groups was the result of continuous communication of the foreign body with the skin surface, the ventricle or the subarachnoid space. This is substantiated by the development of infections (though less severe than in previous groups) in two of the four animals in which the ventricle was traversed by the shot. This does not necessarily imply a greater intrinsic resistance to infection on the part of the cerebral tissue, but rather suggests that the greater danger of contamination of the ventricles or subarachnoid space arises from the rapid spread of the infection by means of the cerebrospinal fluid. This is borne out by the findings in dog N 7 (Group I) who survived 14 days with an extensive intraventricular infection which was sealed off from the adjacent cerebrospinal fluid spaces.

Group VI.—In six dogs, nails were inserted into the brain to a depth of approximately 10 Mm. (as in Group III). After varying intervals, under ether anesthesia and with aseptic precautions, the nails and surrounding area of bone (about 2 cm. in diameter) were removed and the dura widely opened. The wounds were then packed open. The results are given in Table VI.

In the first two dogs, the operation was performed two days and in the third three days after insertion of the nail. Active infection was found in two of these three animals. All three made complete recoveries after operation. The wounds drained freely at first, then gradually filled with granulations and healed. N 45 and N 46 were completely healed on the fifteenth day and N 47 on the nineteenth day after operation.

In the remaining three animals, operation was performed five days after insertion of the nail in N 48 and seven days in N 49 and N 50. Dog N 48 died the day follow-



(A) (B)
FIG. 4.—Embedded shot with healed “cores.” The ventricles have not been penetrated.
(A) Dog N 42, eighty-fifth day. (B) Dog N 41, one hundred and sixth day.

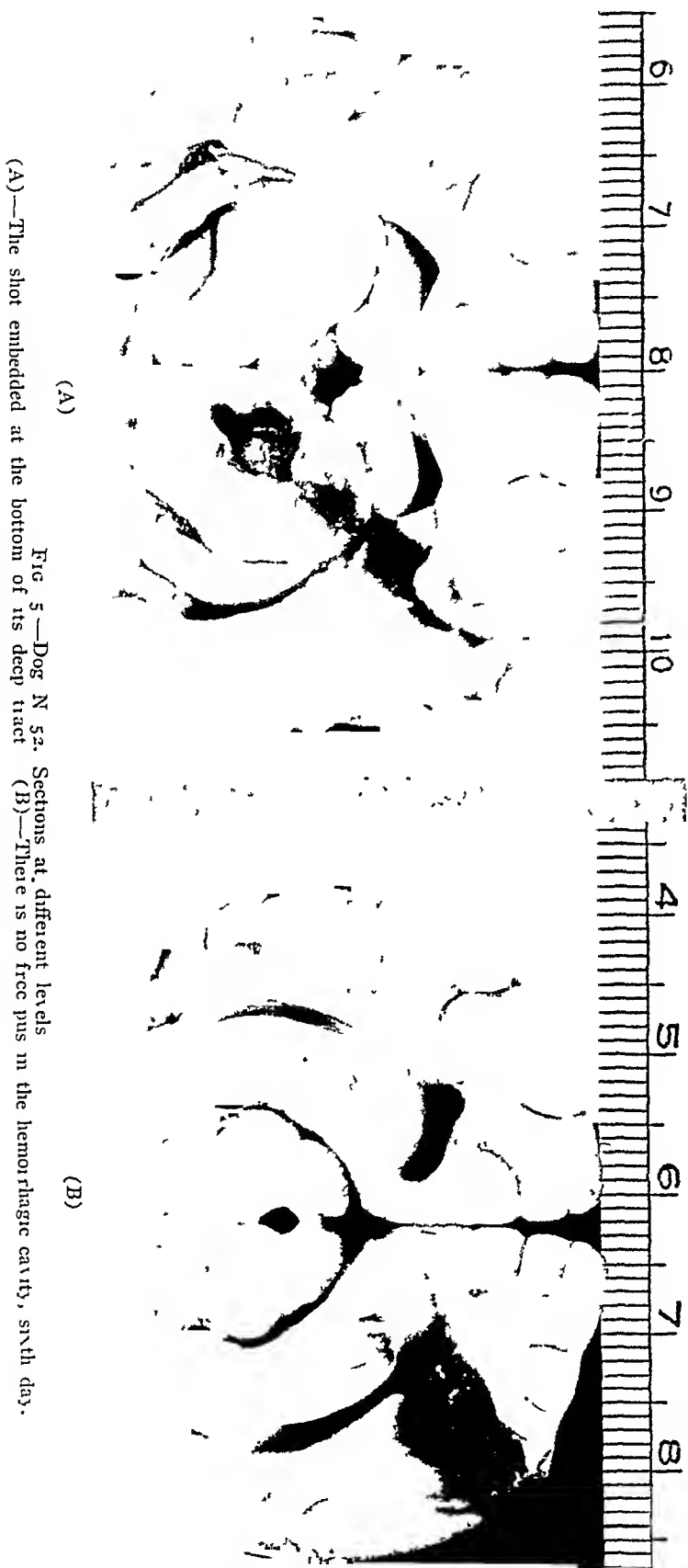


FIG 5.—Dog N 52. Sections at different levels
(A)—The shot embedded at the bottom of its deep tract (B)—There is no free pus in the hemorhagic cavity, sixth day.

TABLE VI

The Effect of the Operative Removal of a Penetrating Protruding Foreign Body with Its Surrounding Area of Bone and Dura Mater. Wound Left Open

Dog No.	Interval Between Insertion of Nail and Operation, in Days	Operative Findings	Postoperative Period, in Days	Spontaneous Death or Sacrifice	Postmortem Findings
N 45	2	No gross infection	84	Sac.	Brain healed. Adhesions. Cortical scar
N 46	2	Small amount of subdural pus	169 plus	—	Still living
N 47	3	Small amount of subdural pus	65	Sac.	Small cortical scar. Dural adhesions
N 48	5	Small amount of subdural pus	1	Sp.d.	Localized cerebral abscess
N 49	7	Cortical granulations. No pus	14	Sp.d.	Walled off subdural abscess
N 50	7	Extensive purulent meningitis	0*	Sp.d.	Extensive meningitis and encephalitis extending into ventricle

* Animal died as anesthetic was begun.

ing operation and was found to have a large localized cerebral abscess. Dog N 50 died as the anesthetic was begun. Hasty removal of the nail with release of pus under great tension failed to resuscitate him. At operation dog N 49 was found to have no actual purulent exudate, but definite evidence of infection. The wound drained profusely and the animal was free of symptoms until the twelfth day after operation. On this day, he was listless and drowsy, refused food and water and looked ill. All extremities were moved well and the reflexes were normal. The following day, high choking of the optic disks was observed. Drainage had greatly diminished. On the fourteenth day the animal died. Necropsy revealed that the infection had become walled off to form a large subdural abscess.

Comment.—These experiments demonstrate that the increase in likelihood of recovery resulting from removal of a protruding foreign body may be augmented by ensuring adequate drainage, providing subdural or cortical infection is already established.

SUMMARY AND CONCLUSIONS

The effects of penetrating wounds of the brain by protruding foreign bodies and by deeply embedded foreign bodies have been studied in 54 dogs. The foreign bodies were unsterile and were inserted to varying depths and left in place for varying periods of time.

Foreign bodies penetrating the ventricle and allowed to remain protruding through the skin invariably produced a fulminating, fatal infection of meninges, brain and ependyma.

Removal of the protruding foreign body within 12 hours after its insertion greatly reduced the incidence of fatal infection.

Failure to penetrate the ventricle by a protruding foreign body considerably reduced the incidence of fatal infection.

Closure of the scalp over the inserted foreign body reduced the incidence of fatal infection and prolonged the survival time if infection developed.

Deeply embedded foreign bodies which did not communicate with the skin or subarachnoid space did not cause fatal infection unless the ventricle had been traversed.

In the presence of established superficial cerebral infection about protruding foreign bodies, early adequate drainage greatly reduced the mortality rate.

The following therapeutic suggestions may be made:

(1) Foreign bodies in the brain which are in communication with the skin, the subarachnoid space or the ventricular system should be removed at the earliest possible moment.

(2) Deeply embedded foreign bodies not falling in the category just mentioned should be removed only if focal irritation or destructive symptoms are present.

(3) If infection already exists about a superficially placed or protruding foreign body, its removal should be accompanied by the establishment of adequate open drainage.

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- ²³² Sargent and Holmes: See ref. ⁶⁰.
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(IX) PAPERS DESCRIBING APPARATUS FOR THE LOCALIZATION AND EXTRACTION
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PULSATING TUMORS OF THE STERNUM

REPORT OF FOUR CASES

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INTEREST in the subject of pulsating tumors of the sternum was stimulated by the difficulties experienced in making the correct diagnosis in a case of hypernephroma of the right kidney which was recently seen at the Cleveland Clinic. In this case the only significant clinical or laboratory finding was a pulsating tumor of the sternum.

CASE I.—A man, 53 years of age, entered the clinic July 31, 1934, complaining of a pulsating lump over the sternum. This lump had been noticed ten months before admittance. The patient remembered that he had occasionally felt a "stinging sensation" over the sternum for nearly a year before the swelling appeared. During the ten months previous to this examination the tumor had slowly and painlessly enlarged and a distinct pulsation had developed.

The family history and the patient's past history had no bearing on the case. There was no history of lues. The patient had had no cardiac or pulmonary symptoms and there was no history of hematuria, frequency, nocturia or dysuria.

Physical examination showed a well developed and well nourished man, apparently in perfect health. The only positive finding was a round, firm, expansibly pulsating tumor about 4 cm. in diameter which apparently arose from the sternum at the level of its junction with the third costal cartilage. The overlying skin was freely movable but the tumor was fixed to the sternum. There was no discoloration of the skin and no dilatation of the superficial veins. A faint systolic bruit was audible over the tumor but no thrill could be felt. The kidneys were not palpable and there was no costovertebral tenderness.

A roentgenogram of the chest revealed no evidence of metastatic malignancy. Repeated urinalyses were negative with the exception of an occasional faint trace of albumen. No red cells were found in the examination of numerous specimens. Examination of the blood revealed 5,300,000 red cells; hemoglobin, 91 per cent; leukocytes, 8,600 with 80 per cent polymorphonuclear neutrophils, 18 per cent lymphocytes, and 2 per cent monocytes. The blood urea was 33 mg. per 100 cc., the blood sugar 109 mg. per 100 cc. and both the Wassermann and Kahn tests were negative.

A roentgenogram of the kidney, ureter and bladder region was made in an attempt to demonstrate a kidney tumor, but no pathologic enlargement of either kidney was noted.

The tentative diagnoses were (1) angiosarcoma; (2) metastasis from an hypernephroma; and (3) aneurysm of the internal mammary artery.

Since the tumor was apparently primary in the sternum, its operative removal was attempted and an encapsulated tumor $4\frac{1}{2}$ cm. in diameter was identified as arising from the sternum. The surgeon was able to enucleate the tumor but this procedure was followed by a profuse hemorrhage which was controlled only by means of packs. Actual cautery with hot irons was then applied in order to obtain hemostasis and to eradicate any remaining traces of the tumor.

Pathologic Examination.—Metastatic hypernephroma.

The patient's postoperative course was uneventful except that the wound was slow in healing and a small area of granulation stubbornly persisted. A search for a primary tumor was instituted but an intravenous urogram on the sixteenth day after operation showed no evidence of a renal tumor and both kidneys were functioning normally. Shortly

before the patient's discharge from the hospital a slight pulsation was visible around the edges of the operative wound.

Since there was no obvious indication as to which kidney was involved, and in view of the pulsation of the thoracic wound, it was somewhat questionable as to whether or not tumor tissue was still present in the sternum, and no further operative procedures were recommended. Several weeks after his discharge from the hospital, the patient died as the result of an accident.

At necropsy an erosion of the sternum was found which was 2 cm. in diameter and was filled with soft yellow tumor tissue. There was a round yellow tumor 5 to 7 cm. in diameter which surrounded the right kidney pelvis. Sections of both these tumors showed a typical picture of hypernephroma. There was no evidence of any metastasis other than that to the sternum.

This interesting case raises a question as to the differential diagnosis of pulsating tumors of the sternum. The importance of the problem is quite obvious since the treatment of the various lesions which can give rise to pulsating tumors of the sternum differs so markedly. For example, confusion as to the diagnosis of an aneurysm, of a primary malignant tumor and of a secondary malignant tumor, could result in a needless fatality or in a useless operation. With this in mind, and with the hope of finding some diagnostic criterion which would be of value in separating the primary from the secondary pulsating neoplasms of the sternum, a review of the literature on pulsating tumors of the sternum has been made.

Sir James Paget,¹ in 1896, stated that "malignant disease of the chest wall receiving pulsation from the heart has been mistaken for aneurysm. The converse error has also been committed." Paget reported six cases of sarcoma of the sternum in none of which was pulsation present. Hedblom,² in an article on tumors of the bony chest wall, speaks of the difficulties in the differential diagnosis of sternal tumors and makes the following statement: "Pulsating sarcoma may simulate aneurysm." No mention of a pulsating sarcoma of the sternum was included in the description of Hedblom's cases. Heuer³ collected 38 cases of tumor of the sternum from the literature; 61 per cent of these tumors he classified as primary sarcomata. Twelve per cent were primary cartilaginous tumors, one was a gumma and one a chronic inflammatory lesion. No tumor in this entire group showed pulsation. The seven remaining cases, in which a diagnosis was stated, were all cases of metastatic hypernephromata, and three of these seven showed pulsation. Heuer and Andrus⁴ also collected a large number of cases of sternal tumor but they do not mention pulsation in any case. The most common origin of the metastatic tumors of the sternum in this series was carcinoma of the breast.

The remainder of the literature on sarcoma of the sternum and on pulsating tumors of the sternum was searched without finding any report of a case of verified pulsating sarcoma of the sternum. Hodgkin's disease, myeloma, tuberculous caries, as well as the above mentioned tumors are reported, but there is no reference to their pulsation or to any likelihood of their confusion with an aortic aneurysm.

In 1882, Rich⁵ reported a case in which a pulsating tumor of the sternum was associated with a pyopericardium together with pyemia and multiple abscesses, but in this case the diagnosis was quite obvious. Cramer,⁶ of von Langenbeck's clinic, reported a case of transmitted pulsation from a retro-sternal tumor of thyroid origin. There was no suggestion in this case but that the origin of the tumor was mediastinal and not sternal. Rankin⁷ reported one case and collected three others of true aneurysm of the internal mammary artery and Weiting⁸ reported two cases of false (post-traumatic) aneurysm of this artery, but in all these cases the tumor appeared lateral to the sternum and the possibility that it arose from the sternum was never considered.

From this brief review of the literature, it is apparent that there is no reported case of a verified pulsating primary neoplasm of the sternum and that with the aid of modern facilities, there should be no difficulty in the diagnosis of pulsating sternal tumors which are due to aneurysms or other non-neoplastic disease.

PULSATING NEOPLASMS OF THE STERNUM

Collected from the Literature

Ten verified and three probable cases of pulsating neoplasm of the sternum have been reported. In five cases in the group in which the diagnosis was verified histologically, the tumors were metastases from hypernephromata of the kidney and in five the tumors were metastases from malignant adenomata of the thyroid. In the other three cases in which histologic studies of the tumor were not made, the description and the clinical course make it highly probable that the tumor was metastatic from a hypernephroma or from a very small and undetected malignant adenoma of the thyroid. No case of verified pulsating sarcoma of the sternum has been reported.

The verified cases of hypernephroma with pulsating metastases which have been reported in the literature are shown in Table I, the cases of probable hypernephroma with pulsating metastases to the sternum are shown in Table II and the verified cases of malignant tumors of the thyroid with pulsating metastases to the sternum are seen in Table III.

The designation of the sternal tumors described in Table III as metastases of malignant adenomata of the thyroid rather than as "benign metastasizing goiters" may at first glance seem somewhat arbitrary. Simpson,²¹ who reviewed these cases carefully, came to the following conclusions: "Metastases of thyroid carcinomata are subject to great variability in microscopic appearance and may assume the structure of normal thyroid tissues, benign thyroid adenoma or simple colloid goiter." There is an abundance of evidence to indicate that there is no such entity as "benign metastasizing goiter" and that the use of this confusing term should be abandoned. Simpson is supported in this conclusion by the more recent studies of Dinsmore and Hicken²² and others who have investigated this problem. The above designation of the

TABLE I
HYPERNEPHROMATA WITH PULSATING METASTASES IN STERNUM
VERIFIED BY NECROPSY OR BIOPSY

Author	Refer- ence Number	Date	Age	Sex	First Symptom or Sign	Sternal Pain	Examination	Roentgen Diagnosis	Evidence of Primary Tumor	Clinical Diagnosis	Treatment	Confirmation of Diagnosis
McLeod and Jacobs	9	1921	51	M	Tumor, upper sternum	None	Pulsating tumor 6 by 6 cm in up- per sternum	Sarcoma of sternum	None; urine nega- tive	Sarcoma	None	Biopsy; hyperne- phroma
McLeod and Jacobs	9	1921	69	M	Pain and tumor, sternum	Yes	Pulsating tumor 3½ by 6 cm in- volving entire sternum	Erosion of sternum	None	Aortic aneurysm	None	Autopsy; tumor size chestnut in left kidney with metastases to sternum
Bshner	10	1908	60	F	Tumor, upper sternum	None	Pulsating tumor 5 by 5 cm upper sternum. Bruit audible	Aneurysm ruled out	None; urine showed only al- bumin and casts	Aortic aneurysm	None	Autopsy; tumor 4 by 5 cm. right kidney meta- stases to lungs, uterus and ster- num
Dresser and Cabot Case	11 12	1923 1930	59	M	Pain followed by tumor, upper ster- num	Yes	Pulsating tumor 10 by 12 cm up- per sternum. Bruit heard	Malignant tumor of sternum	None, urine nega- tive	(1) Aortic aneu- rysm. (2) Later primary neo- plasm	Attempt at excision. X-ray	Autopsy; hyperne- phroma of kid- ney with metas- tases to ilium, sternum
Roth, Louis	13	1931	55	F	Tumor, upper sternum	None	5 pulsating nodules 1½ by 1½ cm upper sternum	Renal tu- mor	Hematuria oc- curred 1 year af- ter appearance of tumor. Red blood cells in urine	Tumor of left kid- ney, vascular tumors of chest wall	X-ray	Autopsy; hyperne- phroma left kid- ney. Metas- tases to ster- num and lungs. Cause of death, primary brain tumor

TABLE II
PROBABLE BUT UNPROVED CASES OF HYPERNEPHROMATA WITH PULSATING STERNAL METASTASES *

Author	Refer- ence Number	Date	Age	Sex	First Symptom or Sign	Sternal Pain	Examination	Röntgen Diagnosis	Evidence of Primary Tumor	Clinical Diagnosis	Treatment	Confirmation of Diagnosis
Damour- ette	14	1890	56	F.	Tumor of upper sternum	None	Pulsating tumor 5 by 4 cm. upper sternum	None	None	(1) Aortic aneu- rysm. (2) Later sarcoma	None	Autopsy; metas- tases in ribs, ilium, femur. vertebrae, and sternum. No histologic ex- amination. No mention made of thyroid or kidneys
Orsi	15	1893	62	M.	Pain and tumor in axilla fol- lowed by tu- mor upper sternum	None	Pulsating tumor of rib and upper sternum	None	None	Osteosarcoma	None	None
Ollivier	16	1868	53	F.	Tumor in upper sternum	None	Pulsating tumor 7 by 12 cm. upper sternum. Bruit heard. Pulsat- ing tumor of skull. Paraplegia	None	None; unless pri- mary tumor was in thyroid, a slight enlarge- ment of which had been pres- ent for many years with re- cent growth	Aortic aneurysm, aneurysm of vessels of skull	None	Autopsy; limited. No mention of kidneys or thy- roid. No histo- logic studies. Tumor had gray color and re- sembled "sar- coma or cancer of bone."

* In spite of the fact that in these cases no mention is made of a primary tumor in the kidney, it is quite possible, especially in view of very incomplete necropsy data pre-
sented, that a small hypernephroma could have been overlooked. In view of the rarity with which bone sarcoma metastasizes to bone, and taking into consideration the normal
appearance of the thyroid, the long course of the disease, the absence of the localizing symptoms and signs which are usually associated with advanced carcinoma of organs other
than the kidney and the absence of descriptions of the kidneys in the postmortem reports, it is quite likely that the primary tumors in these cases were hypernephromata.

TABLE III
MALIGNANT ADENOMATA OF THYROID WITH PULSATING METASTASES IN STERNUM
VERIFIED BY NECROPSY OR BIOPSY

Author	Reference Number	Date	Age	Sex	First Symptom or Sign	Sternal Pain	Examination	Röntgen Diagnosis	Evidence of Primary Tumor	Clinical Diagnosis	Treatment	Confirmation of Diagnosis
Maingot	17	1926	73	F	Tumor upper sternum	None	Pulsating tumor 7½ by 7½ cm upper sternum. Dilated overlying veins	Destruction of manubrium	Two enlarged cervical nodes. Thyroid normal to palpation	None stated	None	Biopsy showed "malignant thyroid tumor"
Cramer	6	1887	49	M.	Pain in chest and left arm	Yes	While in hospital following removal of goiter, pulsating tumor of upper sternum developed	—	Goiter	Aortic aneurysm	None	Autopsy, "Multiple metastases of malignant thyroid tumor"
Helbing	18	1901	51	F	Tumor, upper sternum	None	Pulsating tumor 6 by 6 cm upper sternum	—	Enlargement of right lobe of thyroid not noticed until years after development of sternal metastasis	Aortic aneurysm	None	Autopsy, malignant thyroid tumor with multiple metastases
Halbron	19	1904	68	F.	Goiter	—	Pulsating tumor 8 by 10 cm upper sternum	—	Soft goiter, 4 years	Aortic aneurysm	None	Autopsy, apparent benign goiter, malignant thyroid tumor involving right sternoclavicular articulation
Carle	20	1897	50	F.	Tumor in sternum	None	Pulsating tumor in sternum	—	None	None stated	Excision	Autopsy, alveolar cancer of sternum. Many small metastatic nodules of typical thyroid structure in lungs*

* There is a possibility that this may have been a parathyroid tumor as postoperative tetany is mentioned. In view of the date (1897) this statement is probably inaccurate. No calcium studies were made and the pulmonary metastases showed definite thyroid structure.

sternal tumors reported in the older literature as metastases of benign goiters therefore seems justifiable.

PULSATING NEOPLASMS OF THE STERNUM

Cleveland Clinic Series

Four cases of malignant adenoma of the thyroid with pulsating sternal metastases have been seen at the Cleveland Clinic. These, with the case of hypernephroma reported above, make a total of five pulsating neoplasms of the sternum which have been observed in a series of 16 tumors of the sternum. These include five primary sarcomata, four metastases from carcinomata of the breast, four metastases from malignant adenomata of the thyroid, one cavernous hemangioma, one chondroma and one hypernephroma. The only tumors that showed pulsation were those which had metastasized from malignant adenomata of the thyroid and from the hypernephroma. This again emphasizes the rarity with which pulsation is observed not only in primary tumors of the sternum, but also in metastatic carcinomata other than hypernephromata or malignant adenomata of the thyroid.

The following cases are those in which metastasis occurred from a malignant tumor of the thyroid gland.

CASE REPORTS

CASE II.—The patient was a woman, aged 63 years. A tumor of the thyroid presenting the typical gross and histologic features of a malignant adenoma had been removed in 1924. Four years later a firm, fixed, painless mass developed over the manubrium. Roentgen examination revealed destruction of bone. A diagnosis of sternal metastasis from a malignant adenoma of the thyroid was made and after the administration of roentgen therapy the patient improved. She was not seen again for two years at which time the mass over the sternum exhibited pulsation, and it was found that metastasis to the ilium had occurred. In 1932, eight years after the thyroidectomy, the patient died with generalized metastases. (Classified as malignant adenoma of the thyroid with multiple metastases including the sternum, verified.)

CASE III.—The patient was a man, 57 years of age, in whom one year before admission a goiter had been partially removed, the surgeon having been forced to stop because of hemorrhage. A biopsy was taken February 14, 1919, which the pathologist reported as presenting the typical histologic features of a malignant adenoma. Three months after the biopsy the patient returned and examination revealed a pulsating tumor of the sternum, a biopsy of which showed the presence of malignant adenoma. (Classified as malignant adenoma of the thyroid with metastasis to the sternum, verified.)

CASE IV.—The patient was a man, 63 years of age, who was first seen at the clinic in October, 1930. He complained of recent enlargement of a goiter which had been present for 35 years. October 3, 1930, a papillary adenoma of the thyroid of questionable malignancy was removed. Four years later it was found that he had a recurrent tumor of the thyroid, a large pulsating tumor of the ilium, destructive lesions involving the cervical vertebrae, and a pulsating tumor involving the upper part of the sternum. A puncture biopsy was reported by the pathologist as showing colloid-containing follicles and a structure suggestive of a malignant adenoma of the thyroid. A diagnosis of recurrent and metastatic malignancy of the thyroid was made. (Classified as malignant adenoma of the thyroid with multiple metastases including the sternum, verified.)

CASE V.—The patient was a man, 68 years of age, who entered the clinic July 2, 1930, complaining of pain in the right hip and the left shoulder. Examination revealed

pulsating tumors of the sternum and of the ilium. A systolic bruit was audible over these tumors. There was a hard adenoma of the thyroid isthmus, 2 cm. in diameter, and a second nodule was present at the lower pole of the right lobe of the thyroid. A roentgenogram showed metastatic carcinoma in the mediastinum, ilium and lungs. Dr. Allen Graham, who saw the patient in consultation, made a diagnosis of malignant adenoma of the thyroid with multiple metastases. (Classified as probable malignant adenoma of the thyroid with multiple metastases including the sternum, unverified.)

In addition to the above cases of pulsating sternal tumors, two pulsating tumors of the inner end of the clavicle have been seen at the clinic. One of these was metastatic from a malignant adenoma of the thyroid while the other was secondary to a hypernephroma.

COMMENT

In this total series (collected and reported) of 18 pulsating neoplasms of the sternum, nine were probably metastatic from hypernephromata of the kidney and nine were probably metastatic from malignant adenomata of the thyroid.

The average age of the patients in whom hypernephroma was present was 58 years and of those with malignant adenoma 60.2 years. The ratio of men to women was 5 to 4 among those with hypernephroma and 4 to 5 among those with malignant adenomata of the thyroid.

In eight of the nine cases of hypernephroma, sternal pain or the appearance of a tumor over the sternum was the first evidence of the disease. In no case were any urinary symptoms or signs observed until after the appearance of the pulsating sternal tumor and in only one case did urinary symptoms appear before the patient's death.

In only four cases of malignant adenoma was the appearance of a tumor or of pain over the sternum the leading symptom. In the other cases, the first symptoms were caused by the primary tumor or by metastasis to regions other than the sternum. In six of the nine cases, there was clinical evidence of the primary thyroid tumor at the time of the first examination.

In every case of malignant adenoma and of hypernephroma, the tumor occupied the upper part of the sternum, with the exception of one case in which the entire sternum was involved. The tumor was usually described as of a firm consistency although the terms "elastic" and "semifluctuant" were occasionally applied to the description of its consistency.

In four of the nine cases of hypernephroma, the diagnosis before biopsy or postmortem was aortic aneurysm. A diagnosis of pulsating primary sarcoma was made in the other five cases.

A diagnosis of aneurysm was made in three of the nine cases of malignant adenoma. No diagnosis was mentioned in two cases. In the remaining four cases the correct preoperative diagnosis was made.

In all nine cases in which appropriate roentgenograms were made, aortic aneurysm was ruled out as the cause of the tumor.

In each group of cases the metastasis was single three times and multiple six times. The survival period after the appearance of the first symptom

averaged 35.9 months in the group in which hypernephromata were present and 32.4 months in the group with malignant adenoma. One patient in whom a malignant adenoma was present survived 17 years after the appearance of the metastatic sternal tumor, although no treatment was given. The average survival period of the three patients treated with roentgen ray was 61 months as compared with 41 months for the patients in whom the sternal tumor was incompletely excised or who had no treatment at all (Table IV).

TABLE IV
PULSATING TUMORS OF THE STERNUM

	Hypernephroma 9 cases	Malignant Adenoma 9 cases
Average age.	58 years	60.2 years
Males.	55.5 per cent	45.5 per cent
Evidence at time of appearance of sternal tumor indicating the presence of the primary tumor.	0 per cent	77.8 per cent
Final clinical diagnosis		
(a) Correct.	0 per cent	44.4 per cent
(b) Aortic aneurysm.	44.4 per cent	33.3 per cent
(c) Primary sarcoma.	55.6 per cent	0 per cent
(d) No diagnosis stated.	0 per cent	22.2 per cent
Single metastasis.	33.3 per cent	33.3 per cent
Survival after first symptom.	35.9 months	32.4 months

A review of the literature on the subject of the skeletal metastases of hypernephromata and malignant adenomata of the thyroid indicates that these two types of tumor are almost unique in their tendency to produce slow growing, pulsating and often single skeletal metastases. Hence it is not surprising that these two tumors are the only neoplasms which have been reported as producing pulsating tumors of the sternum.

Pulsation is rarely present in sarcomata, and the sternum is an unusual site for the development of a sarcoma. It is therefore not remarkable that no report of a verified case of pulsating sarcoma of the sternum is to be found in the literature.

The metastases from carcinomas of the breast (the only other metastatic tumor which frequently involves the sternum), have not been reported as showing pulsation. Aneurysms of the internal mammary artery and other rare conditions giving rise to pulsations in this vicinity have not been confused with neoplasms of the sternum. Therefore, the only difficulty in the clinical differentiation of pulsating tumors of the sternum is in distinguishing between aortic aneurysms and metastases from hypernephromata or from malignant adenomata of the thyroid. If aortic aneurysm is ruled out by roentgenologic studies of the mediastinum and if examination of the thyroid does not suggest a malignant change, the sternal tumor is in all probability a metastasis from a hypernephroma and pycelograms should be made. Finally it should be remembered that even if these are negative, the tumor may still be a hypernephroma, for the primary tumor is often very small.

TREATMENT.—No report could be found in the literature of a case of hypernephroma with a single metastasis or of a malignant adenoma of the

thyroid with a single metastasis in which both the primary and the secondary tumor had been removed and the patient cured. Numerous cases have been reported in which the metastatic tumor has been mistaken for a primary sarcoma and a radical resection has been performed. The patient reported by Albrecht²³ lived for ten years after the resection of a metastatic hypernephroma of the scapula. Geschickter and Copeland's²⁴ patient received radium treatment for a metastatic hypernephroma and was alive more than 12 years after the onset of symptoms. Roentgen therapy apparently held the growth in check in the case reported by Dresser¹¹ and the patient lived seven years and four months after the onset of symptoms and five years after partial extirpation of the sternal tumor, followed by roentgen therapy.

Despite these apparently favorable reports of the results obtained in the treatment of these metastatic tumors, it must be remembered that adequate surgical treatment of a sternal metastasis should involve resection of the sternum, an operation which is not without hazard. Hypernephromata, moreover, are usually considered to be quite resistant to irradiation. Roentgen or radium treatment can doubtless temporarily benefit the majority of patients with metastases from thyroid tumors, but it is not certain that either can effect a permanent cure. The apparently favorable results of such treatment must be viewed critically when one remembers that in the case reported by Helbing,¹⁸ the patient lived 17 years after the sternal metastasis was first noticed and that this patient received no treatment of any kind.

In view of the naturally slow development of the disease, it is therefore probable that the more conservative treatment (irradiation) is preferable. If, however, the primary tumor is operable and if the patient is willing to accept the hazard of an attempt at complete extirpation both of the primary tumor and of the single metastatic lesion, there is apparently a possibility that this hitherto unreported procedure might result in a permanent cure. The only difficulty is in ruling out the presence of undetectable generalized metastases which, if present, would make the operation a futile procedure.

SUMMARY

(1) The importance of the correct preoperative diagnosis of pulsating tumors of the sternum is emphasized.

(2) Aortic aneurysm can be differentiated from a neoplasm of the sternum by roentgenographic examination of the mediastinum.

(3) No verified case of pulsating primary neoplasm (sarcoma, *etc.*) of the sternum could be found in the literature.

(4) Thirteen cases of pulsating neoplasm of the sternum have been reported in the literature and five more are added from the records of the Cleveland Clinic. Nine of these were probably cases of metastatic hypernephromata and nine were probably metastases from malignant adenomata of the thyroid.

(5) If a pulsating tumor of the sternum is not an aortic aneurysm, it is probably a metastasis from a malignant adenoma of the thyroid or from a hypernephroma.

(6) Resection of a pulsating neoplasm of the sternum should never be performed until every effort has been made to demonstrate the presence of a primary hypernephroma or of a malignant adenoma of the thyroid.

(7) The possibility of successful resection both of the primary tumor and of its single metastasis is discussed.

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CHOLANGIOGRAPHY

VISUALIZATION OF THE GALLBLADDER AND BILE DUCTS DURING AND AFTER OPERATION

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THE uncertainty of diagnosis in diseases of the gallbladder and bile ducts contributes to the difficulties encountered in their surgical management. Our present diagnostic methods usually detect a diseased gallbladder but unfortunately they give but meager information concerning the provocative factors. For example, a cholecystogram merely evidences a normal or nonfunctioning gallbladder without revealing whether the disease is within the liver, the bile ducts or the gallbladder itself. The common bile duct may be occluded by a stricture, neoplasm, calculus, by extrinsic pressure, or from a spasm of its sphincter, and there is no way, other than exploration, of determining the causative agent. Even the direct operative examination is not infallible, for occasionally the surgeon fails to detect an elusive common duct stone; he may not recognize the physiologic blockade caused by a spasm or dys-synergia of the choledochal sphincter; he may be unable to demonstrate a pathologic obstruction to account for the dilated but otherwise normal appearing gallbladder; and he may even overlook small strictures or neoplasms. Hence, studies which facilitate the recognition of abnormalities that may interfere with the function of the liver and its ductal system are worthy of investigation.

Direct roentgenographic visualization of the biliary tree is a valuable diagnostic and therapeutic procedure. The injection of such radiopaque substances as lipoiodine directly into the gallbladder and bile ducts gives an accurate graphic picture of conditions as they really are. Diagnostically, it demonstrates whether the ductal system is patent or occluded; it notes the position and number of calculi; it defines the extent and location of strictures; it denotes the functional status of the sphincter of Oddi; it outlines fistulous communications; and it demonstrates dilatation and sacculation of the bile ducts. It also has definite therapeutic value for it enables one to determine how long the dilated biliary tract should be drained; it confirms the patency of the common duct before the drainage tubes are removed; it demonstrates whether a cholecystostomy will decompress the entire biliary

system; it helps to ascertain the cause of persistent external biliary fistulae; and occasionally the lipoiodine lavage will flush out small stones, sand, or mucous plugs that are causing the patient postoperative pain and discomfort. Any test, therefore, which graphically outlines the gallbladder and the minute ramifications of the bile passages is certain to reduce diagnostic and therapeutic errors.

The urologists were quick to develop the visualization studies of the genitourinary tract, thereby converting a haphazard problematical subject into one of the most exact specialties of medicine. We can profit by their example, for much information can be obtained by making graphic studies of the gallbladder and bile ducts. The technic and value of such cholangiographic observations are presented.

TECHNIC

There are two methods by which cholangiography, or visualization of the biliary system, can be accomplished. One plan, to be known as immediate cholangiography, consists of injecting some radiopaque substance such as lipoiodine into the gallbladder and bile ducts during the operation and making roentgenographic observations while the patient is still on the operating table. The other procedure, designated as delayed cholangiography, utilizes the drainage tubes, which were inserted into the gallbladder and biliary radicals at the time of operation, or the external biliary fistulae, for the introduction of the contrast solution. These visualization studies of the hepatic system may be made at any desired time. The indications for and value of each method will be emphasized by case presentation.

Lipoiodine is an efficient, nontoxic, nonirritating substance which gives an excellent graphic reproduction of the biliary system. No unfavorable systemic reactions were observed in spite of the fact that this contrast medium was injected into inflamed gallbladders, into infected bile ducts, and was used in the presence of stones, strictures, and even pancreatitis. The stock lipoiodine is a rather viscid substance; therefore, we have been diluting it to 33 1/3 and 50 per cent of its original concentration by adding sterile olive oil. The resultant mixture, when heated to body temperature, forms a labile solution, which readily flows into the smaller biliary radicals. Further dilutions are not advisable as the solutions then lose their contrast values. Stereoscopic roentgenograms combined with fluoroscopic studies yield much more detailed information than does a single flat film of the liver area.

Immediate Cholangiography.—Immediate cholangiography is particularly indicated in those problem cases in which the diagnosis is questionable or in which the selection of the proper surgical procedure is difficult. Although our experience has been limited to a comparatively few cases, we feel that it has definite merit. The technic is rather simple. The gallbladder is first exposed and the entire ductal system is carefully examined for abnormalities. The gallbladder is then collapsed by aspirating its bile contents, following which 40 to 60 cc. of warm lipoiodine are slowly injected into the

gallbladder lumen through the aspirating needle. If the cystic duct is patent, the contrast solution immediately enters the choledochus and outlines the entire ductal system. By means of a portable roentgen ray unit, roentgenograms are taken immediately, and if anatomic abnormalities are noted, the surgeon can proceed with the proper corrective measures.

Whitaker¹⁵ demonstrated that the gallbladder and bile ducts fill only when the choledochal sphincter is closed. The anesthetic, particularly spinal anesthesia, may cause the sphincter of Oddi to relax and permit the lipiodine to flow unhindered into the duodenum, thus failing to outline the small biliary



FIG. 1.—(Case I) Immediate cholangiography. Forty cc. of lipiodine were introduced into the common duct via the stump of the cystic duct. The oil immediately escaped into the intestinal tract, proving the choledochus to be patent. As there were no abnormalities at the ampulla, there was no need to explore the common bile duct. The tube was removed, the cystic duct was ligated and the abdomen closed.

radicals. In such an event, if further studies are necessary the intestinal orifice of the common bile duct can be occluded by placing a small gauze pack against the second portion of the duodenum and the bile ducts again injected with the radiopaque material. We are now investigating the influence of anesthetics on the choledochal sphincter.

After removing the gallbladder, the surgeon may desire to test the patency of the common duct before closing the abdomen. This can easily be accomplished by injecting the lipiodine directly into the choledochus, or through the stump of the cystic duct. If the visualization studies fail to show the pres-

ence of strictures, neoplasms, stones or dilatation of the bile ducts, and if the contrast solution enters the intestinal canal, then the common duct need not be explored or drained. Mirizzi⁹ was the first to make a practical application of immediate cholangiography.

CASE I.—Mrs. A. A., housewife, aged 29, entered the hospital with the chief complaint of "gallbladder pains." Following her first pregnancy two and one-half years ago, she had had recurrent attacks of sharp colicky pains in the right hypochondrium associated with nausea, vomiting, jaundice and acholic stools. Physical examination and laboratory studies were normal with the exception of two cholecystograms which demonstrated a poorly functioning, dilated gallbladder.

At operation the gallbladder was found to contain three small stones and was distended with a golden brown bile. The walls of the cystic duct were indurated, edematous and fibrosed. The common and hepatic bile ducts were slightly dilated but otherwise normal. The head of the pancreas was firm, indurated and slightly enlarged.

After performing a cholecystectomy, a small rubber catheter was inserted into the stump of the cystic duct and 40 cc. of lipoiodine were injected into the choledochus. The bile ducts were not visualized because the oil immediately entered the duodenum (Fig. 1). The indurated swollen pancreas was not acting as a mechanical obstruction to the flow of bile; therefore there was no indication for common bile duct drainage. The catheter was removed, the cystic duct was ligated and the patient made a very rapid convalescence.

Cholangiography is practical because of the ease with which such studies are performed. If one does not desire or is unable to insert a catheter into the stump of the cystic duct, the contrast media can be injected directly into the common duct by means of a needle, and then the necessary radiographs made. Had we been interested in visualizing the entire ductal system in this patient, it would have been necessary to occlude the duodenal end of the common duct by pressure on the second portion of the duodenum and then to reinject the lipoiodine. In this particular instance, however, we were merely interested in the patency of the duct at the ampulla because of the associated pancreatitis. These visualization studies do not increase the time required for operation more than ten minutes.

Delayed Cholangiography.—In delayed cholangiography, or the postoperative visualization study of the extrahepatic bile ducts, the lipoiodine is injected into the drainage tubes which were sutured into the gallbladder or biliary ducts at the time of operation, or into the external biliary fistulae. Roentgenograms are taken immediately after the oil has been introduced, thus obtaining an exact outline of the biliary system. If any abnormalities are noted, then serial roentgenograms are taken at 15 minute intervals until the diagnosis is established. The value of these studies can best be demonstrated by presenting actual cases.

(a) *Determining the patency of the cystic duct.*—The therapeutic value of a cholecystostomy does not entirely depend on the simple drainage of the diseased gallbladder but is also dependent upon the decompression and drainage of the entire hepatic system. If the cystic duct is occluded prior to or subsequent to the operation, then the value of a cholecystostomy is definitely minimized, for the bile ducts and hepatic radicals are not drained. It is true that the inflammatory occlusion of the cystic duct usually disappears after draining the infected gallbladder for a week or ten days. It is, how-

ever, during this crucial period that the entire ductal system should be drained so as to facilitate the reestablishment of hepatic functions and to reduce the high morbidity and mortality rates of acute cholecystitis and cholangitis. One cannot accurately determine the functional status of the cystic duct by direct observation and palpation. Immediate cholangiography, or injection of lipoiodine into the gallbladder, will readily test the patency of the cystic duct, but one hesitates to utilize the visualization studies in the presence of acute infections for fear of disseminating the inflammatory process. Thus far, however, we have had no unfavorable reactions following lipoiodine injections in seven cases of cholangitis. The value of cholecystostomy and choledochostomy in cases of generalized suppurative process of the biliary tree is problematical and will require additional investigation. One cannot forget that the gallbladder is but a small part of the biliary system and that if the cystic duct is occluded a cholecystostomy merely drains a small segment of the infected area. Might not the high morbidity rate following the drainage of the gallbladder be due to a retention of infected bile in the large bile ducts and hepatic radicals? Investigations are now being carried out, hoping thereby to answer some of these questions.

CASE II.—J. H., farmer, 53 years of age, was admitted to the hospital because of "indigestion." During the past four years he had been annoyed by the belching of gas, the passage of flatus, and epigastric distress. Occasionally, the colicky pains became quite severe. He denied ever having been jaundiced.

On examination the skin was found to have a definite icteric tinge. In the right hypochondrium there was a firm, ovoid, fixed, tender mass. The liver could not be differentiated from the tumor and the gallbladder was nonfunctioning according to the cholecystogram.

At operation the gallbladder was found to be moderately distended. Its walls were thickened, indurated and scarred. The liver appeared normal except for the fibrosis of its capsule. The common duct was about twice its usual size and in its retroduodenal portion there was a small lobulated mass which was thought to be either an enlarged lymph node or an incarcerated intramural calculus. Exploration of the choledochus disclosed a firm annular stricture just distal to the junction of the hepatic and cystic ducts. This cicatricial band had reduced the lumen of the common duct to one-fourth its original size. The location and extent of the stricture precluded the possibility of its excision for the continuity of the bile ducts could not be reestablished, nor could a hepatico-enterostomy be done. After demonstrating that the duodenal portion of the common duct was patent a cholecystostomy and choledochostomy was performed. This conservative procedure not only decompressed the biliary system but it left the gallbladder intact so that a cholecysto-enterostomy could be performed at a later date should the inflammatory stricture again occlude the common duct.

While scooping out the calculi from the gallbladder, about 20 cc. of brownish yellow bile escaped, indicating that the cystic duct must be patent. A large rubber tube was firmly anchored into the gallbladder for drainage purposes. The stricture in the common duct was divided longitudinally and a T-tube was inserted in such a manner that one limb of the T would dilate the constricted portion of the duct. Much to our surprise, for we had thought that the cystic duct was patent, no bile drained from the cholecystostomy tube. Apparently all the bile could find an easy exit by the T-tube or else the cystic duct had become occluded. In order to answer this question, the following studies were made.



Fig. 2.—(Case II.) Forty cc. of lipiodine were injected into the gallbladder through the cholecystostomy tube. The gallbladder was only partially visualized as the oil escaped around the drainage tube. Stereoscopic studies indicated that the occluded cystic duct had prevented the lipiodine from entering the common duct. The arrow points to a collection of oil outside of the choledochus. During the operation it was thought that the cystic duct was patent, but cholangiographic studies demonstrated a postoperative occlusion of this duct.



Fig. 3.—(Case II.) Sixteen days later the visualization studies were repeated. The gallbladder was filled with oil, the cystic duct was patent, and the lipiodine had filled the dilated common duct. Note the obstruction at the terminal portion of the choledochus. Progressive roentgenographic observations demonstrated this to be a spasm of the choledochal sphincter.

Forty-eight hours after the operation, 40 cc. of lipoiodine were injected into the cholecystostomy tube. Roentgenograms were taken immediately and again in 20 minutes. In both instances, the lipoiodine was confined within the gallbladder for it had been unable to traverse the cystic duct (Fig. 2). This seemed to contradict the operative findings for it must be remembered that apparently normal bile was found in the gallbladder, indicating the cystic duct to be open. Evidently the operative trauma had initiated sufficient tissue reaction to produce an inflammatory obstruction of the cystic duct.

This observation teaches the object lesson that a cholecystostomy does not always decompress and drain the entire biliary system. If a patient should have an associated cholangitis and bile stasis due to choledochal obstruction, then the mere drainage of the gallbladder would not relieve the intraductal pressures or permit the infected bile to escape. In this particular instance, it was 16 days before the blockade was removed so that bile and lipoiodine could pass unhindered through the cystic duct (Fig. 3). Fortunately, the T-tube in the common duct had supplied adequate drainage of the hepatic radicals and facilitated the recovery of the patient. It is conceivable that the unfavorable response of some patients with acute empyema of the gallbladder to a simple cholecystostomy might be due to the inflammatory occlusion of the cystic duct. Visualization studies at the time of operation or during the convalescence of the patient will help determine the patency of these structures. In this small series of 11 cases, we encountered two instances in which the roentgenographic studies demonstrated a complete occlusion of the cystic duct. In both instances the common bile duct was drained, permitting the infected bile to escape, and thus facilitating the recovery of the patients.

(b) *Determining the cause of persistent external biliary fistulae.*—Since the work of Lanari and Squirri⁶ in 1924, visualization of bile ducts by introducing lipoiodine into the external fistula has become an established diagnostic procedure. The contrast media not only locates the obstructive agent but it gives information which is invaluable in selecting the operation best suited to correct the existing abnormalities.

CASE III.—L. B., farmer, 56 years of age, complained of "gall running from his side." Four months previously he had had a cholecystostomy performed elsewhere, at which time several small stones were removed from the gallbladder. He had a stormy convalescence associated with chills, fever, and a persistent drainage of bile from the operative area. During the past six weeks the flow of bile had become intermittent. During the period of free drainage he felt fine, but when the external sinus became occluded he had severe colic and epigastric pains. The major portion of bile was passing into the intestinal tract as his stools were of normal color and he had no evidence of jaundice. Apparently he had a partial obstruction in the cystic duct which permitted bile to flow into the gallbladder but prevented it from returning to the common duct.

In order to obtain a graphic outline of the biliary system, 60 cc. of lipoiodine were injected into the external biliary fistula. Roentgenograms were made immediately. The gallbladder was well visualized and no calculi were seen. The distal portion of the cystic duct was definitely outlined, showing an irregular spiral-shaped shadow. It was impossible to say whether this shadow represented hypertrophied spiral valves of

Heister, an inflammatory swelling of the cystic duct, or several small stones. The distal end of the cystic duct was apparently occluded for the warm lipoiodine did not flow from the gallbladder into the common bile duct in spite of being injected under positive pressure. The lipoiodine was then diluted with twice its volume of olive oil, the resulting mixture heated to body temperature and injected into the fistula, but even this more labile solution did not enter the common duct. It seemed highly improbable that the cystic duct was completely occluded, for bile had been draining from the fistula but 24 hours previously. A second roentgenogram made 30 minutes later showed that a very small amount of oil had slowly trickled into the duodenum (Fig. 4). From these visualization studies it was concluded that the external biliary fistula was caused by a partial occlusion of the cystic duct.

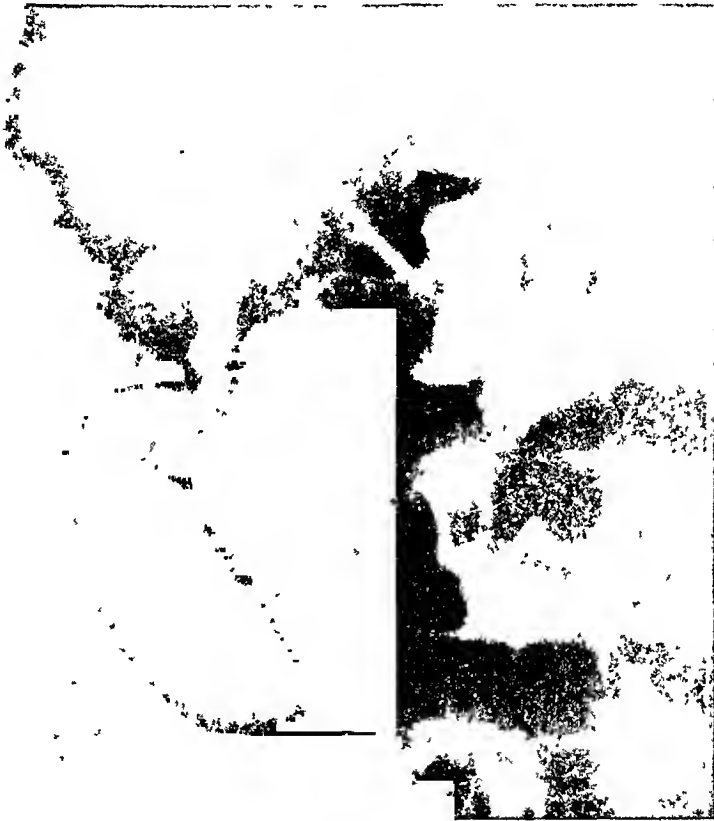


FIG. 4.—(Case III.) Sixty cc. of lipoiodine were injected into the external biliary fistula. The gallbladder appeared normal. The proximal three-fourths of the cystic duct was visualized but exhibited some peculiar configurations that were taken to be the spiral valves of Heister. The distal one-fourth of the duct was occluded. An organized bile stained mucous plug was found to obstruct the cystic duct and it protruded into the neck of the gallbladder. Bile could enter the gallbladder but the ball valve action of the clot prevented its return through the cystic duct, hence the external fistula.

Operative intervention confirmed this diagnosis, for a long, well organized, bile stained mucous plug filled the entire cystic duct and projected into the neck of the gallbladder. This plug was firmly anchored to the walls of the cystic duct and had a spiral configuration, thus accounting for the peculiar roentgenographic outline. Along the anterior surface of the plug was a small groove which permitted bile to enter the gallbladder, but the ball valve action of the intravesical portion precluded its escape. A cholecystectomy was performed, the wound healed by primary intention, and the patient made an excellent recovery.

CASE IV.—Mrs. A. M., housewife, 50 years of age, was admitted to Doctor Hunt's service because of a persistent external biliary fistula. Seven years ago a cholecystectomy had been performed. The wound refused to heal and there had been a continuous

drainage from the fistulous tract. At times her stools were acholic but as a rule they had a brownish color. Five months prior to admission, the fistula healed spontaneously. She then became jaundiced, her stools were acholic and she had considerable epigastric distress. Two months later the sinus tract opened and there was a copious discharge of bile. She immediately felt improved, but the jaundice did not disappear.

Examination revealed a poorly nourished, jaundiced, asthenic woman. There was a continuous discharge of mucopurulent bile from the fistulous tract. The liver was slightly enlarged. A radiograph of the abdomen revealed an indefinite opacity just to the right of the second lumbar vertebra. This was interpreted as being a stone in the common duct.

The instillation of 20 cc. of lipoiodine into the external fistula demonstrated a dilated

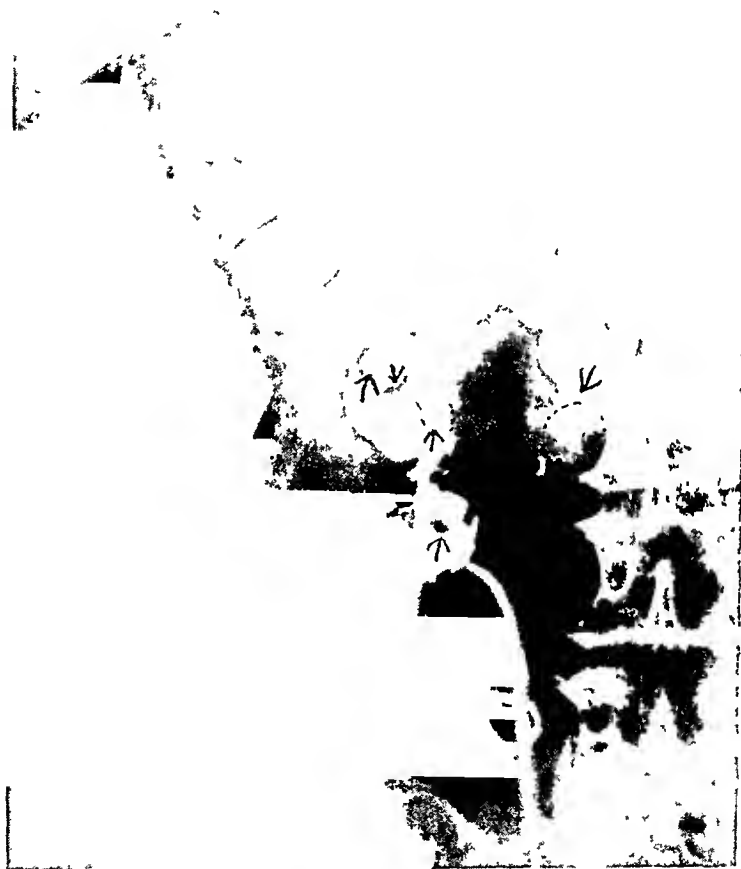


FIG 5 —(Case IB) Twenty cc. of lipoiodine were injected through a biliary fistula of seven years' duration. Multiple small calculi could be seen along the fistulous tract and a stone measuring 2 cm in diameter practically occluded the ampulla. Note the enormous dilatation of the bile ducts. This roentgenogram gives definite evidence why the biliary fistula did not heal.

sinus tract containing several small stones. The hepatic ducts and choledochus were of enormous size, the latter measuring 20 Mm. in diameter. The terminal portion of the common bile duct was obstructed by a large stone measuring 10 by 15 Mm. The mechanical blockade was not complete as a small trickle of lipoiodine managed to seep around the calculus (Fig. 5).

At operation several small stones were removed from the fistulous tract and four calculi from the choledochus. After extracting the large stone from the ampulla of Vater, the common duct was found to be patent. A small catheter was then anchored into the cystic duct for drainage purposes. The patient developed a severe suppurative

cholangitis and died one week after operation. These studies merely emphasize the value of cholangiography in determining the etiology of persistent biliary fistulae.

(c) *How long shall we drain the common duct?*—Cicatricial and calculous obstructions of the common bile duct are not dangerous in and of themselves but they effect their damage by indirectly diminishing the functional capacity of the liver. These obstructive agents cause an accumulation of bile resulting in a cylindrical dilatation of the biliary radicals, pressure atrophy of the hepatic cells, interference with the portal circulation, and if there be a co-existing infection, then a cholangitis, hepatitis and liver insufficiency follow.

Restoration of liver function then largely depends on removing the obstruction and controlling the infection. Ravdin¹² maintains that choledochostomy tubes should not be removed until the bile becomes microscopically and chemically normal, otherwise there is a retardation of the reparative processes. Thorlakson and McMillan¹³ demonstrated roentgenographically that prolonged drainage of infected bile ducts resulted in a disappearance of the cholangiectasia and a cessation of the infection. In order to determine the effects of prolonged drainage of the choledochus, progressive visualization studies were made over 33-day periods in several patients, a typical case of which is presented.

CASE V.—C. M., farmer, aged 69, came to the hospital because of "stomach trouble." For the last 35 years he had had considerable epigastric distress, characterized by bloating, passage of flatus, and gaseous eructations. He had suffered from recurrent attacks of jaundice, at which times his stools were acholic and his urine contained bile. He had lost 55 pounds of weight during the past ten months.

On examination a large, firm, fixed tumor was found in the epigastric area. The liver, spleen, and kidneys were not palpable. His skin and sclera were definitely jaundiced. Roentgenograms demonstrated a nonfunctioning gallbladder and several small calculi which were thought to be in the common bile duct. During the preoperative period, he had several chills and a temperature of 106° F. which indicated a cholangitis secondary to an intermittent calculous obstruction. The large tumor mass, the rapid loss of weight, and the persistent jaundice made the diagnosis of pancreatic malignancy associated with cholelithiasis seem plausible.

At operation the liver was found to have a dark green nutmeg color. It was slightly enlarged and its capsule was tense and fibrotic. The gallbladder was about twice its usual size and its walls were indurated and edematous. The cystic duct appeared to be patent. The choledochus was dilated to about three times its regular diameter and after aspirating 60 cc. of black, viscid bile, several stones could be palpated in the hepatic and common ducts. The pancreas was enlarged, firm and swollen but it did not present the stony hardness of a malignancy. The gallbladder was removed and several stones were extracted from the hepatic ducts. Painsstaking examination failed to show any gross obstruction at or near the ampulla of Vater. A T-tube was anchored in the common duct.

Visualization studies were deferred until the twelfth postoperative day because of acute cholangitis. Then 40 cc. of lipiodine were permitted to flow into the T-tube. Roentgenograms which were taken immediately showed a definite dilatation of the common duct. The hepatic ducts and small biliary radicals were not visualized because the coexisting cholangitis and relaxed sphincter of Oddi had permitted the oil to drain into the duodenum (Fig. 6). On the twenty-ninth (Fig. 7) and again on the thirty-third (Fig. 8) postoperative days, visualization studies were made. The bile ducts were no

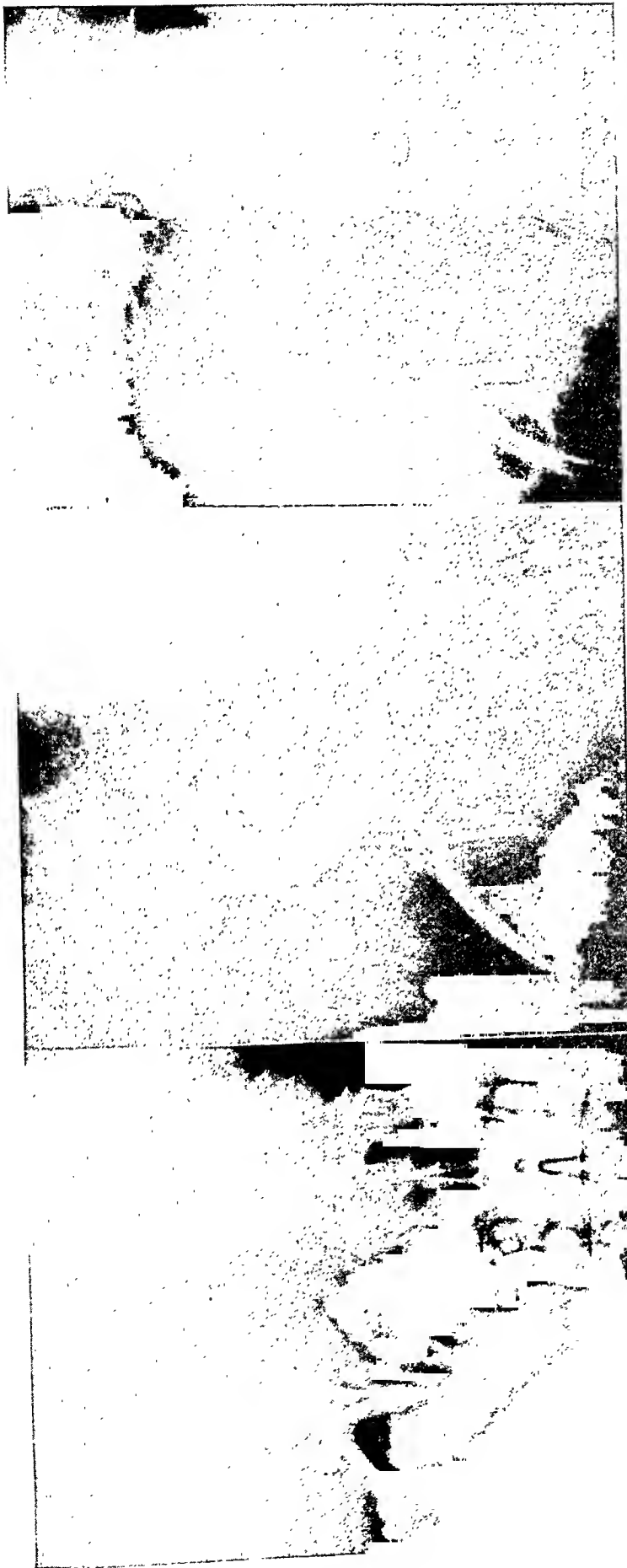


FIG. 6.—(Case V.) On the twelfth postoperative day, 40 cc. of lipiodine were injected into the common duct. Note that the choledochus is dilated and that its relaxed sphincter permitted the oil to enter the duodenum in spite of a coexisting pancreatitis and cholangitis. Apparently inflammation of the common bile duct and adjacent structures does not necessarily produce a choledochal spasm.

FIG. 7.—(Case V.) Lipiodine studies on the twenty-ninth postoperative day. The common bile duct is much smaller than before and the small biliary radicals are visualized, indicating a subsidence of the inflammatory process.

FIG. 8.—(Case V.) Cholangiogram made after 33 days of continuous drainage of the common bile duct. Note that the bile ducts are no longer dilated and that the inflammatory process has subsided, permitting the small hepatic radicals to be visualized. Comparison with Figs. 6 and 7 demonstrates the value of prolonged drainage of infected and dilated biliary trees.

longer dilated and the small radicals were patent, the graphic pattern of the entire biliary tree was practically normal. It was apparent that the prolonged drainage had facilitated the rehabilitation of the liver. Microscopic studies of the bile evidenced a rapid subsidence of the infectious process, for after 16 days of drainage no pus cells or bacteria could be found in the biliary secretions.

Biliary Dyssynergia: Obstruction of the Common Bile Duct by a Spasm of the Choledochal Sphincter.—There is a wealth of clinical evidence which indicates that a dyssynergia or spastic contraction of the common bile duct sphincter may produce an evanescent physiologic obstruction of the choledochal lumen and result in stasis of bile. Many surgeons have encountered a dilatation of the entire biliary tract but have been unable to demonstrate any pathologic impediment to account for the cholangiectasia. Krukenberg,⁵ in 1903, reported a case of "gallstone colic" in which neither calculus nor infection was found. Aschoff and Basmeister¹ made an intensive study of the "stasis gallbladder" which occurred in the absence of stones, infections, strictures or anatomic deformities, and conceived the idea that a purely functional derangement of the choledochal sphincter might account for this condition. The work of Westphal,¹⁴ Meltzer,⁸ Lyon,⁷ Berg,² Newman¹⁰ and Ivy¹ indicates that a spasm or dyssynergia of the sphincter of Oddi may mechanically block the common duct and produce a stasis of bile with its attending colic and icterus. Newman, Nuboer,¹¹ and Giordano and Mann³ have all reported cases in which a mild jaundice has resulted from a choledochal dyssynergia.

The diagnosis of biliary dyskinesia, or what we wish to call dyssynergia because of its more appropriate description, has previously been based on direct operative findings, supplemented by information obtained from duodenal intubation (Ivy, Newman and Meltzer) and the reaction of the biliary system to certain drugs (Westphal, Meltzer and Lyon). In our review of the literature we were unable to find roentgenographic evidence pointing to an actual spasm or dysfunction of the choledochal sphincter in man, and yet there is definite clinical and physiologic proof of its existence. Fortunately, while making these visualization studies of the bile ducts we encountered five patients who presented definite evidence of a dyssynergia or spasm of the common bile duct sphincter. Our findings were all corroborated by operative examination. The following case is representative of the group.

CASE VI.—Mrs. A. C., housewife, aged 50, had suffered from paroxysms of nausea, vomiting and epigastric distress for the last one and one-half years. At times the sharp colicky pains became very severe. During the last nine months she had had a persistent jaundice, her stools had been acholic and she had lost 66 pounds in weight.

Examination revealed a poorly nourished, asthenic, deeply jaundiced woman. The liver extended two inches below the costal margin. The gallbladder could not be palpated. The stools were acholic but the urine contained bile. The van den Bergh reaction was positive in both the direct and indirect phases and the ieteric index was 75. The general appearance of the patient, the rapid loss of weight and the persistent jaundice suggested either malignant changes in the hepatobiliary system or a pronounced liver damage from long standing calculous obstruction of the common bile duct,



FIG. 9.—(Case VI.) On the fifth postoperative day 40 cc. of lipiodine were injected into the common duct via its drainage tube. Note the pronounced dilatation of the bile ducts. The lipiodine has encountered an obstruction at the distal end of the choledochus for the oil has not entered the duodenum.



FIG. 10.—(Case VI.) Ten minutes later. The choledochal obstruction is beginning to disappear as the oil is slowly trickling into the intestinal lumen.

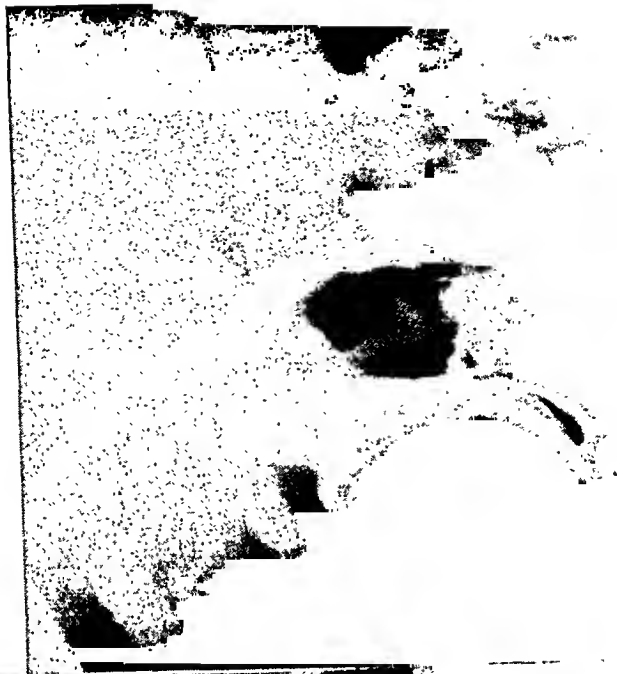


FIG. 11.—(Case VI.) Thirty-five minutes after the injection. Note the stasis of lipiodine in the larger bile ducts. The oil is flowing into the duodenum more rapidly. It required three hours before the obstruction had completely disappeared and the oil had passed into the lumen of the bowel. No obstruction was found at the operation. The location and the evanescent character of the obstruction signify a spasm of the choledochal sphincter.

After ten days of preoperative preparation, the abdomen was opened. The liver had a dark green, nutmeg appearance indicating a chronic retention of bile pigments. The dilated gallbladder contained many small stones and its walls were thickened, firm and indurated. The fundus of the gallbladder was angulated in such a manner that it was adherent to the common duct, there being a fistulous communication between the two. The common duct was about twice its regular size but no abnormalities could be found to account for this dilatation. Even after opening the choledochus, neither stones nor strictures could be felt; however, gentle irrigation with saline solution flushed out some fine gravel, several small calculi and inspissated plugs of bile-stained mucus. Catheters, probes and irrigating fluids were passed into the duodenum, thus attesting to the patency of the common duct. The gallbladder was held in firm apposition to the liver by dense adhesions and, because of the associated jaundice, it was felt unwise to attempt a complete cholecystectomy for fear of hemorrhage. The anterior and lateral walls of the gallbladder were excised, leaving the posterior portion intact in its hepatic fossa. The mucosa of the remaining gallbladder tissue was destroyed by carbolic acid and the muscular coats were firmly approximated by sutures. Catheters were placed in both the choledochus and common hepatic duct.

On the fifth postoperative day, 40 cc. of lipiodine were injected into the common duct via the drainage tube. Roentgenograms which were made five minutes later demonstrated a pronounced dilatation of the larger biliary radicals, particularly of the right and left hepatic ducts. Interestingly the lipiodine had encountered some impediment at the distal end of the common bile duct, for the oil had not entered the duodenum (Fig. 9). A second roentgenogram taken ten minutes later indicated that the obstruction was beginning to disappear as a small quantity of oil was then trickling into the intestinal canal (Fig. 10). Studies made 35 minutes later demonstrated a partial retention of lipiodine. It required three hours for the obstructing mechanism to disappear so that the choledochus could evacuate its oily content into the duodenum (Fig. 11).

This case presented definite visual evidence of a temporary choledochal obstruction in spite of the fact that the operative examination revealed the common duct to be patent. At first, the blockade was complete (Fig. 9), but subsequent roentgenograms disclosed a gradual recession of the obstructive agent which finally permitted the oil to enter the intestinal lumen. The location of the mechanical block and its evanescent character indicated a spastic contraction of the choledochal-duodenal sphincteric mechanism. A spasm of this sphincter could readily occlude the orifice of the common duct and produce a dilation of the entire ductal system by causing a retention of bile.

CASE VII.—Mrs. J. W., housewife, 41 years of age, has had "gallbladder trouble" for the past five years. The colicky pains were associated with nausea, vomiting, passage of flatus and occasionally with jaundice. Two years ago a gallbladder filled with stones was removed and 22 pea sized calculi were extracted from the choledochus and hepatic ducts. Four months following the cholecystectomy she had a recurrent attack of colic associated with jaundice and several calcium bilirubin stones were recovered from the feces. Similar attacks were experienced during the next few months and on one occasion fragments of a large irregular stone were found in the stool. She began to lose weight, complained of weakness and had considerable abdominal distress. Intermittent chills followed by a temperature varying from 100° to 106° F. indicated a calculous obstruction of the common bile duct complicated by a cholangitis.

At operation, the choledochus was found to be as large as the duodenum and, on incising it, a thick yellowish pus escaped, indicating a suppurative cholangitis. A large



FIG 12 —(Case VII.) On the sixtieth postoperative day 30 cc. of lipiodine were injected into the external biliary fistula. The contrast media outlined a large subcutaneous cavity from which a small sinus tract led to the dilated common bile duct. At the terminal part of the choledochus there was a definite obstruction for the oil did not enter the duodenum.



FIG 13 —(Case VII.) Progressive roentgenograms made three minutes later indicated that the obstructive mechanism was changing its form and some of the oil had escaped into the intestinal tract, but there was still a stasis of lipiodine in the choledochus.



FIG 14 —(Case VII.) Roentgenograms made 20 minutes later demonstrated that the obstructing mechanism had disappeared for the subcutaneous cavity and bile ducts had evacuated the only content into the intestinal tract, signifying a relaxed and patent choledochal sphincter. Had the obstructing agent been a blood clot or stone, the blockade should have persisted rather than disappearing within 20 minutes' time.

calculus occluded the ampulla of Vater. This stone measured three-fourths of an inch in diameter and it was of soft mushy consistency. Careful investigation revealed the common duct to be patent so it was drained by a T-tube and a small catheter was placed in the dilated stump of the cystic duct.

On the first postoperative day, there was a slight subcutaneous hemorrhage which necessitated opening the wound and ligating the bleeding vessels. Five hundred cc. of yellowish mucopurulent bile were collected from the drainage tubes each day. On the tenth postoperative day the biliary discharge had a definite bloody tinge but the stools contained no blood. The bleeding became progressively worse in spite of repeated blood transfusions and the administration of several hemostatic substances. She began to complain of abdominal pain and it was apparent that intracholedochal bleeding had formed a blood clot which was obstructing the common duct as the amount of bile drainage through the tubes had practically stopped and her stools were acholic.

The abdomen was reopened on the fourteenth postoperative day and several blood clots were removed from the sinus tract. After removing the T-tube a large organized blood clot measuring 4 cm. in length and $1\frac{1}{4}$ cm. in diameter was extracted from the choledochus and hepatic ducts. A definite imprint of the T-tube was present on the anterior surface of the blood clot. There was a gush of bile from the hepatic ducts as soon as the obstruction had been relieved. The inner surface of the common duct was red, inflamed, and hyperemic, but the exact origin of the bleeding could not be determined. Instrumental examination demonstrated the ampulla to be patent, so a rubber catheter was sutured into the common duct. She was then given several postoperative blood transfusions.

Bleeding from the choledochus stopped spontaneously but there was considerable oozing from the abdominal wound and there was a profuse drainage of bile from the catheter. The stools were persistently acholic. She then developed a mass in the right lumbar gutter and a large fluctuant tumor in the pelvis. The culdesac was opened and six ounces of pus escaped. The hematoma of the right flank was drained.

During the next 21 days she gained in weight and the anemia improved; the biliary drainage was profuse, but her stools remained acholic. On a number of occasions the external biliary sinus was firmly packed with gauze but within two hours she experienced so much discomfort that the gauze plugs had to be removed. No bile was found in the feces even after the administration of atropine and magnesium sulphate. It seemed impossible to force the bile into the intestinal canal in spite of the fact that the choledochus was patent at operation. Hoping to determine the cause of this obstruction, a cholangiograph was made.

Sixty days following the first operation, 30 cc. of warm lipiodine were injected into the common duct via the fistulous opening. The contrast medium revealed a large subcutaneous cavity communicating with enormously dilated bile ducts. There was a definite obstructive agent at the distal end of the common bile duct which prevented the lipiodine from entering the duodenum (Fig. 12). A roentgenogram taken three minutes later demonstrated that a few drops of oil had escaped into the terminal duodenum, apparently indicating that the obstructive agent was beginning to disappear (Fig. 13). A third roentgenogram taken 20 minutes later revealed that the subcutaneous pocket and bile ducts had evacuated their contents into the intestinal tract, thus proving the choledochal sphincteric mechanism to be relaxed (Fig. 14). Immediately following the injection of the lipiodine, the bile began to enter the bowel and within 48 hours' time the external biliary fistula had stopped draining.

It seems unreasonable to believe that a blood clot or residual stone could have been dislodged by the instillation of lipiodine because she experienced no pain during this manipulation. It is to be remembered that the common duct was found to be patent at the operation, and yet no bile appeared in

the feces. Furthermore, the visualization studies indicate a gradual disappearance of the obstructive factor similar to that seen in patients having a choledochal sphincterismus. The most logical explanation of this unusual phenomenon is that the oil apparently produced a relaxation of the hyper-spastic sphincter and established free drainage of the biliary passage.

Fig. 15 (Case VIII) represents an excellent cholangiogram of a patient who had a definite spasm of the choledochal sphincter, *i.e.*, biliary dyssynergia.

A functional dyssynergia of the choledochal-duodenal sphincteric mech-



FIG. 15.—(Case VIII.) This patient gave a typical history of biliary colic. At operation the gallbladder was found to contain numerous calculi and the bile ducts were all dilated. No gross obstruction of the common duct could be found. Forty-eight hours after the cholecystectomy had been performed, 40 cc. of lipiodine were injected into the choledochostomy tube. Roentgenograms showed the choledochus and hepatic ducts to be dilated to three times their usual size. No stones, strictures or neoplasms were seen. In the terminal part of the common duct there was a mechanical obstruction which prevented the oil from entering the intestinal tract. Roentgenograms which were taken three hours later revealed that the obstructive agent had completely disappeared as the oil had escaped into the duodenum.

anism occurs much more frequently than we had thought. In a routine study of 11 patients undergoing operations for infections and calculi in the biliary system, four cases presented definite anatomic and roentgenographic evidence of this condition. Apparently the easiest and most accurate method of detecting the choledochal sphincterismus is by cholangiographic visualization.

What is the clinical significance of this biliary dyssynergia? A cardio-spasm prevents the ingested foods from entering the stomach; a pyloro-spasm causes an obstructive gastric retention; a hypertonicity of the rectal

sphincter initiates constipation and fecal stasis; and a sphincterismus of the bladder neck interferes with micturition. It is not unreasonable, therefore, to believe that the choledochal sphincter can, by its spastic contraction, interfere with free flow of bile into the duodenum and thus produce a chronic biliary stasis.

If the accumulation and stagnation of bile within the ductal system is caused by the obstructive action of the hypertonic choledochal sphincter, then the removal of the gallbladder or drainage of the ducts will not correct the sphincterismus or ameliorate the distress of the patient. Repeated visualizations were made on such individuals for as long as 33 days after the operation and the dyssynergia still persisted.

Recognition of this choledochal dyssynergia by cholangiographic studies is very beneficial for corrective measures may then be employed. Berg has demonstrated that the sphincter is controlled by the autonomic nervous system; therefore, its spastic contractions can be overcome by using atropine. Newman and Ivy suggest that the duodenal instillation of olive oil and magnesium sulphate will relax the choledochal sphincter and drain the distended ducts. We have demonstrated on a number of occasions that lipoiodine injected into the common duct releases the sphincterismus or removes the offending obstruction. The use of such simple therapeutic procedures might mitigate the physical discomforts from which some cholecystectomized patients suffer. It is only by the direct visualizations that one can obtain graphic evidence of the functional status of the sphincter and when abnormalities are seen, then the proper therapeutic regimen can be instituted.

SUMMARY

(1) Cholangiography, or roentgenographic visualization of the gallbladder and bile ducts, is a very valuable diagnostic and therapeutic procedure. Diagnostically, it demonstrates the presence of calculi, strictures, neoplasms, fistulae, and attests to the patency of the bile ducts. It has a definite therapeutic value, for it helps to determine how long the dilated biliary system should be drained, it confirms the patency of the common bile duct before removing the drainage tubes, it demonstrates whether a cholecystostomy will decompress and drain the entire hepatic ductal system, it helps to ascertain the cause of an external biliary fistula, and occasionally a lipoiodine lavage of the common duct will flush out small stones or inspissated plugs of mucus which are causing distress and discomfort in cholecystectomized patients, or perhaps release the sphincterismus.

(2) Immediate cholangiography consists of injecting some radiopaque solution as lipoiodine directly into the gallbladder and bile ducts at the time of operation. Roentgenographic observations are made immediately following the injections of the oil and the operative procedures employed are determined by the radiographic findings. An example of the efficiency and simplicity of this method is given.

(3) Postoperative visualization studies of the extrahepatic ductal sys-

tem, or delayed cholangiography, are made by injecting lipoiodine into drainage tubes which are anchored in the gallbladder and bile ducts at the time of operation. These roentgenographic studies can be made at any desired time. The value of these observations is demonstrated by case presentations.

(4) Lipoiodine is a nontoxic, nonirritating substance which gives an excellent graphic reproduction of the entire biliary system. It was used in cases of acute cholecystitis, cholangitis, and in the presence of strictures, calculi, and pancreatitis without causing any local or systemic reactions.

(5) A spasm of the choledochal sphincteric mechanism or biliary dys-synergia is discussed and roentgenographic demonstrations of its existence are evidenced by delayed cholangiography.

(6) A cholecystostomy, to be of the most value, must not only drain the gallbladder but it must decompress and drain the entire hepatic ductal system. If the cystic duct is occluded, then only the gallbladder will be drained and the bile ducts may still retain the stagnant bile and the intraductal pressure will not be reduced. Cholangiography is very valuable in determining the patency of the cystic duct.

(7) The beneficial effects of prolonged drainage of the bile ducts in cases of cholangiectasia and cholangitis are discussed and cholangiographic observations are presented.

(8) The introduction of lipoiodine into an external biliary fistula gives valuable information concerning its etiology as well as suggesting the most feasible method of correction.

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DIVERTICULOSIS OF THE SMALL INTESTINE

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THE vast majority of acquired diverticula of the small intestine are of the mucous membrane hernia type, similar to the pouches so frequently to be found in the large intestine.

The diverticula are usually multiple, and are practically limited to the upper part of the jejunum, the ileum being affected only in extreme cases.

Historic Note.—The first complete description to be found in the literature of multiple jejunal diverticula, in which no doubt exists as to the nature of the diverticula in question, was by Sir Astley Cooper¹ in 1844, who found numerous pouches of the upper part of the jejunum in a man of 65. The condition appears to have excited little comment at that time, and very few other references are to be found until the last decade of the nineteenth century, though Osler²⁵ in 1881 found at postmortem in a man of 65, who had suffered from rumbling noises after food, 55 diverticula in the upper part of the jejunum, ranging in size from a cherry to a large apple.

In the following decade, Virchow,³⁶ who described a case of "Hernias in the Jejunum and Ileum," Edel, Grassberger,¹³ Henseln, Hansemann,¹⁶ Hanau,¹⁵ and Nicholls,²⁴ all describe personal cases, and give their views of the pathogenesis. Hansemann's case is the most famous. He found no less than 400 diverticula in a single case—a man of 85. Some of these were duodenal, and some in the upper part of the ileum, but the vast majority were jejunal.

Keith included a description of a specimen of jejunal diverticula in an article written in 1910, and there have since followed descriptions of the condition by Taylor and Lakin³³ (1910), Latarjet and Murard²⁰ (1914), Terry and Mugler,³⁵ and Mackechnie (1921), Caraven and Helvestine¹⁴ (1923), Berry⁴ (1927), Lund (1928), Jenkinson,¹⁷ and Weiss (1929), Boling⁵ (1930), and Tengwall³⁴ (1931). In 1922, Braithwaite⁶ published his remarkable operative case, to which the writer, who has had the opportunity to examine the specimen, will subsequently refer.

Material.—The following description of the morbid anatomy and pathogenesis of acquired diverticula of the jejunum and ileum is based upon an examination of six postmortem and three operative specimens.

Unlike duodenal diverticula, pouches lower down the small intestine are difficult to detect by roentgenography, except in the comparatively rare cases in which there is retention of barium in them, and they will, therefore, be more often missed than not.

In 4,631 barium meals the author found only four cases in which

diverticula could be diagnosed with certainty. This makes the percentage incidence 0.086 per cent, a figure probably far too low. Jenkinson¹⁷ records three cases in many thousand roentgenograms.

Autopsy Statistics.—2,820 autopsies with nine cases of diverticula (0.31 per cent). This is a more reliable guide than roentgenography, but is still too low. During the past four years, in which 881 autopsies have been made, and in which particular attention was given to the search for diverticula, five cases, either single or multiple, have been discovered, an incidence of 0.57 per cent. In these cases the criterion of the acquired nature of the diverticulum has been absence or deficiency of the muscular coat. This is probably a more accurate figure of incidence, and agrees more closely with the expressed opinions of many postmortem workers.

The author's seven postmortem and three operative cases are summarized in Table I.

TABLE I

Case	Situation	Number	Sex	Age	Clinical Notes
1 (Fig. 1)	Upper part of jejunum	18	M.	55	Death from pulmonary embolism. No symptoms noted during life
2 (Fig. 5)	Upper jejunum	6-8	F.	38	Operative specimen
3	Upper part of jejunum	6	F.	63	Road accident; death No history
4 (Fig. 6)	Jejunum 18 ins. from flexure	1	M.	48	Death from cerebral thrombosis. No symptoms noted during life
5 (Fig. 7)	Jejunum	1	M.	7	Native of Madras. No clinical history
6 (Fig. 8)	Jejunum	1	F.	62	Death from cerebral tumor
7 (Fig. 11)	Jejunum	1	F.	57	Malignant growth affecting jejunum
8 (Fig. 17)	Ileum or lower end of jejunum	1	M.	53	Operative case. Acute inflammation of the diverticulum
9	Jejunum	1	M.	49	Operation. Diagnosed by roentgenogram. Diverticulum excised
10 (Fig. 10)	Jejunum 9 ins. from flexure	1	M.	55	Death following partial gastrectomy for gastric ulcer

Eight of these cases have been examined histologically and they are all of the acquired type, with the probable exception of No. 8. In all but one of the cases the pouch or pouches arise from the mesenteric side of the intestine. No. 6 is the exception, the single diverticulum lying opposite the mesenteric attachment.

In one of the cases a malignant growth was associated with the pouch. This was an unique case, and, though it is impossible to establish a cause and effect formula with regard to the pouch and the growth, the case must be classified apart from the others.

To these must be added the remaining two of the four cases diagnosed roentgenographically, in whom operation was not performed (Table II).

TABLE II

Case	Situation	Number	Sex	Age	Clinical Notes
11	Jejunum: upper part	Multiple	M.	67	Flatulent dyspepsia
12	Jejunum: upper part	Multiple	M.	69	Flatulent dyspepsia

Age and Sex Incidence.—The age incidence is a relatively high one, the youngest patient being 49, the oldest 69. The average age for 11 cases was 56 years. Eight were men and four were women.

In the 15 cases of multiple diverticula which the author has selected from the literature as being undoubted examples of the type of diverticula under discussion, the average age in 14 was 62, the youngest 43, and the oldest 85 years. The latter case contained 400 diverticula. Of the 15 cases nine were men and six women (Table III).

TABLE III

	Sex	Age	Number
Cooper.....	M.	50	Multiple
Osler.....	M.	65	53
Virchow.....	M.	old	Multiple
Good.....	F.	77	6
Hansemann.....	M.	85	400
Nicholls.....	F.	64	45
Gordinier and Sampson.....	F.	46	13
Taylor and Lakin.....	F.	68	Multiple
Braithwaite.....	M.	45	60
Case.....	M.	61	12
Case.....	M.	73	25
McWilliams.....	M.	71	7
Terry and Mugler.....	F.	59	5
Mackechnie.....	F.	43	13
Helvestine.....	M.	63	58

It should be borne in mind that the mean age calculated from these figures represents the age of discovery of the diverticula. The mean age of development would be a much lower figure.

PATHOLOGIC DESCRIPTION OF THE AUTHOR'S CASES

SPECIMEN I.—The specimen (Fig. 1) was obtained at postmortem upon a man of 55, who died from a pulmonary embolism following an operation upon the bladder. There had been no indication of the presence of the diverticula during life.

The specimen consists of the upper part of the jejunum, commencing two inches below the duodenojejunal flexure. This segment of intestine is studded with diverticula varying in size from that of a split pea to that of a chestnut. In all, 18 can be counted. The diverticula are all situated at or near the mesenteric border of the intestine, pushing their way between the leaves of the mesentery. Looking at the specimen from the lateral aspect, a well defined vessel is seen running in the thin wall of each pouch and continuing, but less clearly seen, on the wall of the bowel towards the antimesenteric edge. These vessels are evenly spaced, and the diverticula, though varying in size, are also equally spaced, each of them being related to a segmental vessel.

If the specimen be viewed now from the mesenteric side, it is seen that the largest diverticula bestride the mesenteric angle, pushing aside the leaves of the mesentery. The opening of the pouches into the bowel is a wide one, and is placed symmetrically over the line of normal mesenteric attachment. The smallest diverticula, however, lie to one side of the mesentery, and their opening into the bowel is lateral to the normal line of mesenteric attachment. Each of the small diverticula is paired. Its fellow is situated equidistantly from the mesenteric line, and on the opposite side. The diverticula of each pair are unequal in size.

The pouches intermediate in size between the largest and the small paired ones are bilobed. The mouth of such a diverticulum bestrides the mesenteric line, and the leaves of the mesentery are reflected away from the intestinal wall as in the case of their larger neighbors. At the fundus, however, there is a grooved depression in the long axis of the diverticulum corresponding with the line of attachment of the mesentery to the normal intestine, and giving each diverticulum its bi-

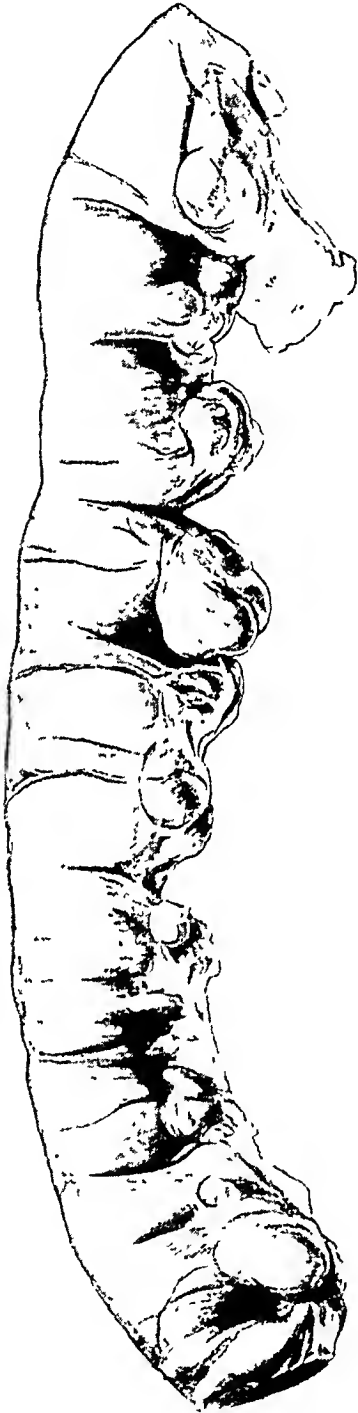


FIG. 1.—Diverticulosis of the jejunum. Postmortem specimen. The pouches are all closely related to the mesentery.

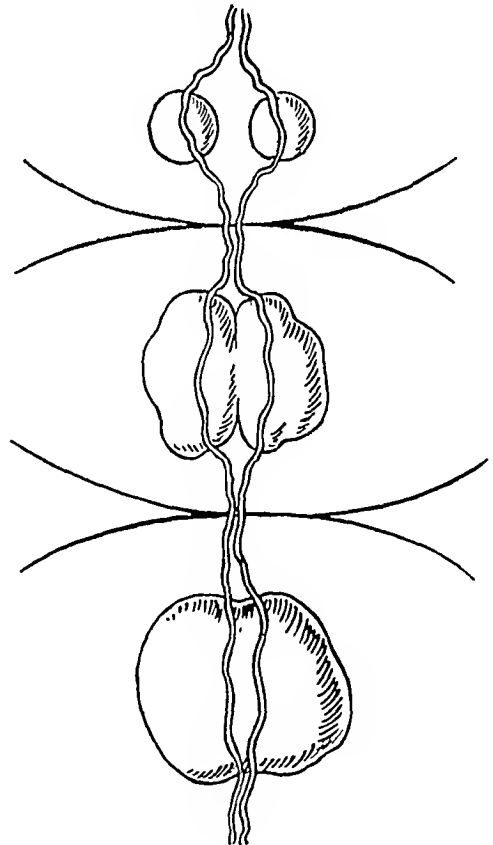


FIG. 2.—Semidiagrammatic drawing of a portion of the specimen illustrated in Fig. 1, viewed from the mesenteric aspect, showing the mode of formation of the pouches.

lobular character. This appearance is represented semidiagrammatically in Fig. 2.

Figure 3 shows a portion of the specimen opened up by cutting along the exact line of the original mesenteric attachment. Valvulae conniventes are present as in the normal intestine.

The separate openings of the small paired diverticula are now clearly shown, one on either side of the mesenteric line. The lower two pairs show the diverticula to be of unequal size, as though one had started life before its opposite, and that from the chronological standpoint the two are not twins. The mouth of each is sheltered by a *valvula connivens*.

In the third segment of the bowel (from below upwards) the mouth of a medium sized diverticulum has been cut through by the incision. The greater portion of the mouth is on the left side as one looks at the picture (Fig. 3).

The mode of formation of each large diverticulum is clear. It started originally as a pair of pouches, one on either side of the line of the mesentery. Later in development the pair became larger, until they met in the line of the mesentery, and the thin strip

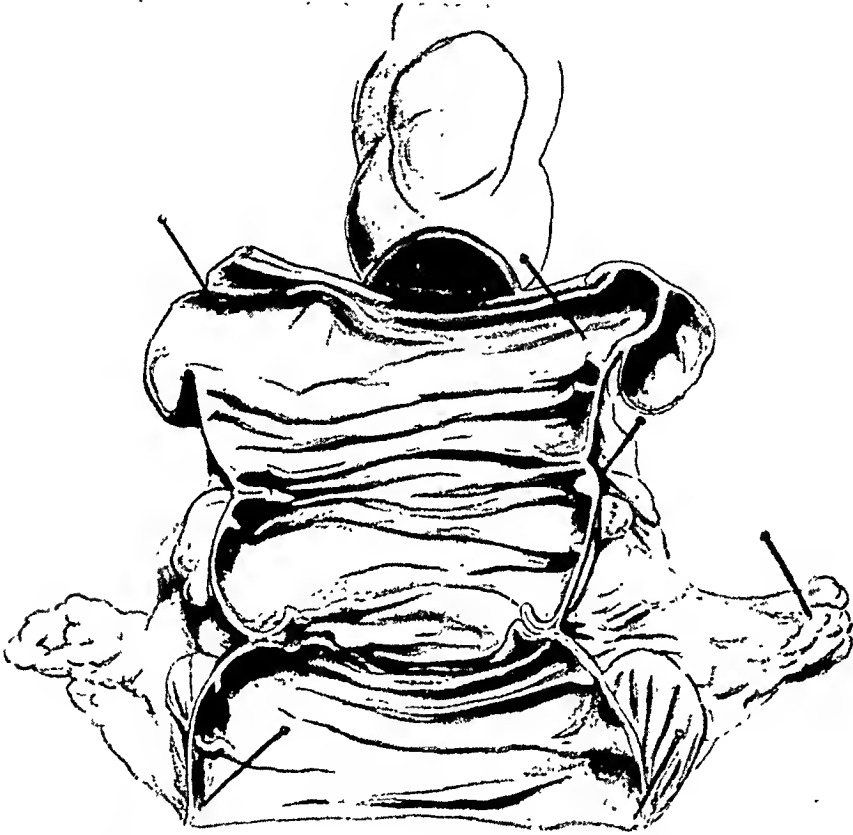


FIG. 3.—The specimen illustrated in Fig. 1 opened by cutting along the line of attachment of the mesentery. Note that the smaller diverticula are paired, each opening immediately lateral to the mesenteric line.

of bowel which separated them originally, became taken up, and the mouths of the two pouches fused. At this stage, the fusion of the pouches was indicated externally by the median longitudinal groove seen on the external aspect on the line of the mesentery. Eventually, as a result of continued pressure from within the bowel, this median groove became obliterated, and a single smooth-walled large diverticulum resulted.

The point which is established is, therefore, that the site of origin of each diverticulum is not at the line of mesenteric attachment to the bowel, as the appearance of the fully developed pouches suggests, but to one or other side of this line. This situation corresponds exactly with the entrance of the blood vessels through the muscular coat of the intestine, as will be described in the succeeding pages.

If the opened specimen is held up to the light, it is at once evident that the walls of the pouches are thinner than the wall of the neighboring bowel. Each diverticulum is thinnest at its fundus.

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Figure 4a is a low power (7 \times) photomicrograph of a section taken through one of the small diverticula. The diverticulum opens by a wide mouth into the parent bowel, and is hemispherical in shape. The mouth is bounded on the right side as one looks at the illustration by a *valvula connivens*. At the fundus of the pouch are a large vein and artery, and smaller branches of these vessels can be seen in both of the angles between the diverticulum and the jejunum.

The mucous membrane lining the diverticulum shows no difference in detail from that of the bowel proper, but as this is a postmortem specimen, the mucous membrane is poorly preserved. There are no rugae present in the diverticulum comparable with the *valvulae conniventes* of the normal bowel.

The wall of the diverticulum is thinner than that of the intestine, and this is due entirely to the difference in width of the respective muscular coats. The fibers of the intestinal muscularis appear to be heaped up at the angles between the pouch and the intestine. On placing a finger in the diverticulum this is felt as a firm prominent edge



FIG. 4a.—Photomicrograph of a section through one of the diverticula ($\times 7$). Note the vessels at the fundus of the pouch and the absence of a muscular coat.

surrounding the diverticulum, almost like a sphincter. At the commencement of the diverticulum, looking at the left side of the illustration, the muscular coat is pushed back upon itself, and is then continued into the diverticulum as a thin layer not more than two to three fibers deep. The layer completely surrounds the diverticulum, getting slightly thinner still as it approaches the intestine on the right side of the mouth. There is a slight interruption in the muscular layer here—probably an artefact.

The muscularis mucosae can be seen on high power examination as a thin layer of small fibers, continuing in an unbroken line from the intestine, underneath the mucous membrane of the diverticulum. These appearances strongly suggest that the mucous membrane has been pushed through a weak area in the muscularis of the bowel carrying with it a thin layer of muscle fibers—a pulsion diverticulum. The point at which this occurred in the intestinal wall corresponds with the entrance of the large blood vessels seen at the fundus of the diverticulum.

At either side of the mouth of the diverticulum, and identified by inclusion within circles, are two areas in which there is a gap in the musculature occupied by blood vessels. A pouching of the mucous membrane into these gaps is seen. The gap on the

left side is better shown, and Fig. 4b is a higher power illustration of this field. Here can be seen a wide interval in the well developed muscularis of the jejunum, occupied by a number of blood vessels. The largest of these is a thin-walled vein, and this corresponds with the apex of a pouch of mucous membrane, which is herniating through the vascular interval to form a diverticulum. From this illustration, one can readily appreciate how the contraction of the muscle at the mouth of the pocket of mucous membrane will force it further into the gap occupied by the vessels and how increased pressure within the lumen of the jejunum will foster its development into a complete hernial diverticulum. As the diverticulum passes through the muscular coat to form a protrusion on the peritoneal aspect of the intestine, it will probably take with it muscular fibers from the wall of the bowel, which will furnish it with a thin muscular coat. At the fundus of the diverticulum, however, there will clearly be no muscle fibers at all, except those belonging to the muscularis mucosae.



FIG. 4b.—Photomicrograph of higher magnification of area enclosed within circle A, Fig. 4a. Note the vascular gap in the muscularis partly occupied by a pouch of mucous membrane.

SPECIMEN II.—The specimen illustrated in Fig. 5 was removed at operation from a woman of 38 who had, for upwards of eight years, complained of flatulence and discomfort, sometimes pain, after food. Six to eight pouches are present and their morphology is *identical* with those of Specimen I. There is a nodule of aberrant pancreatic tissue on the antimesenteric aspect of the bowel.

SPECIMEN III.—The third case in the series was sacrificed in order to obtain microscopic sections through all of the six diverticula present. The diverticula were spaced out along the mesenteric border at regular intervals of about five inches. Each pouch was related to a large blood vessel at its entry through the wall of the intestine. Four of the pouches were single, but two were situated next one another on opposite sides of the mesenteric angle. None of the pouches contained any muscle at the fundus with the exception of small thin fibers belonging to the muscularis mucosae.

SPECIMEN IV.—In this case there is a solitary diverticulum situated 18 inches from the duodenojejunal flexure (Fig. 6). It was obtained postmortem from a man of 48, who died from cerebral thrombosis. No symptoms referable to the presence of the diverticulum were noted during life.

The diverticulum is the size of a small chestnut. It is situated wholly to one side of the mesentery, and does not push between the leaves. There is no trace of any

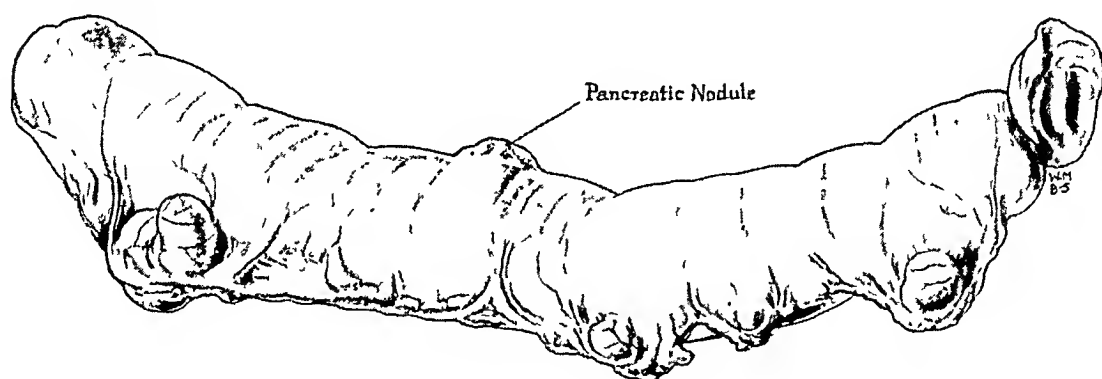


FIG. 5.—Diverticulosis of the jejunum. Operative specimen. There is an aberrant pancreatic nodule on the antimesenteric aspect of the bowel.

diverticulum on the reverse side of the mesentery on gross examination, though the possibility that an early one is present and would be revealed by microscopic section cannot be denied when one considers the mode of formation of the largest diverticulum described in Specimen I. There is a vessel associated with the diverticulum, and branches of this can be seen in the lateral view under the peritoneal coat.

Microscopic section of the jejunal wall shows nothing abnormal, beyond a poorly staining mucous membrane, due to postmortem digestion. A section of the diverticulum passing through the angle formed by it and the intestine is illustrated in Fig. 7. The muscularis of the latter is doubled back upon itself so that it appears thicker than normal and looks almost like a sphincter. As the muscle coat passes into the wall of the diverticulum, it rapidly becomes thinned. The longitudinal fibers suffer first, but both layers share in the process, and at a distance of 0.5 cm. from the mouth of the diverticulum all that remains of the muscularis is a thin sheet of muscle, not more than 2 to 3 fibers in breadth, which by the direction of their long axis appear to be remnants of the circular layer.

The submucosa has practically disappeared in this specimen, and the mucous membrane is a little thinner than in the bowel. Two or three vessels are present in the angle, lying underneath the peritoneal coat, and standing some distance from the wall of the bowel (an artefact).

SPECIMEN V.—This specimen (Fig. 8) was sent to the author by a doctor practicing in Madras, who stated in his letter that such diverticula were a common finding at postmortem among the natives of that part of India.



FIG. 6.—Solitary diverticulum of the jejunum, situated immediately lateral to the mesentery.



FIG. 7.—Photomicrograph of a section of the specimen illustrated in Fig 6 (X7). Note the heaping of the muscular coat in the angle

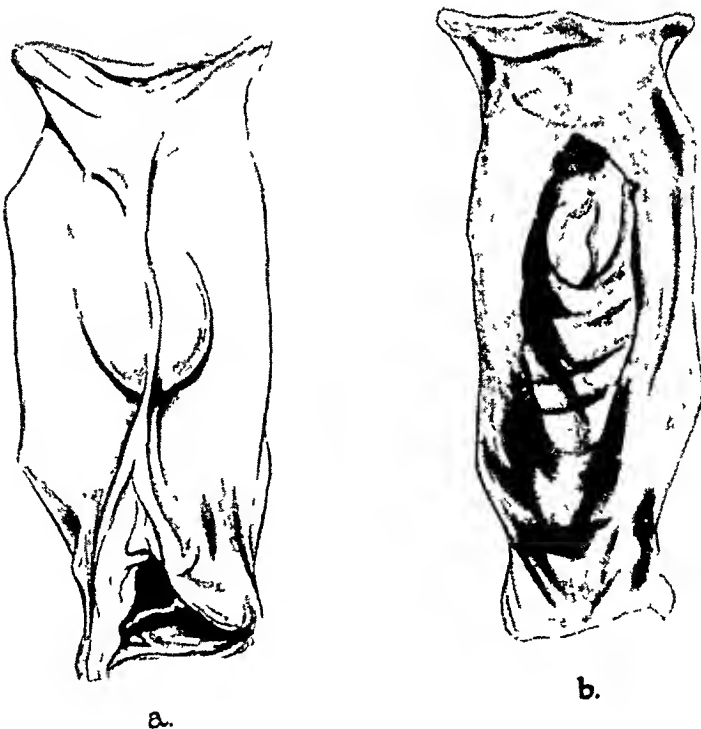


FIG. 8—(a) Solitary jejunal diverticulum. It bestrides the mesenteric angle; (b) was drawn with the specimen hung in front of a bright light, and demonstrates the thinness of the wall of the pouch.

DIVERTICULOSIS OF SMALL INTESTINE

There is a single diverticulum pushing its way into the leaves of the mesentery, somewhat flask shaped, and opening into the intestine by a wide mouth. The mesentery is not placed symmetrically across the diverticulum, but divides into two unequal portions, suggesting that the diverticulum is developed by fusion of two diverticula of unequal size. Viewed from inside the lumen of the bowel, the mouth on one aspect is bounded by a sharp crescentic ridge. On the other aspect the lumen of the gut slopes down into the diverticulum without such interruption.

The illustration Fig. 8b was made with the specimen hanging down in front of a bright light. The diverticulum throws a shadow to the left side of the mesentery. The greater translucency of the wall of the diverticulum as compared with that of the normal bowel is clearly shown.

The microscopic section made of the wall of the diverticulum shows an absence of true muscle coat, the latter ceasing abruptly at the mouth of the pouch.

SPECIMEN VI.—This specimen (Fig. 9) was obtained at postmortem upon a woman of 62, who died from a cerebral tumor.

There is a small diverticulum on the *antimesenteric* border of the jejunum, and in view of its situation the case is unique. It is not a Meckel's or any other type of congenital diverticulum as microscopic examination proves, but a pulsion or primary acquired diverticulum. Running into its wall is an artery of unusual size—much larger than any of its collaterals. Instead of breaking up into terminal branches half way along the wall of the intestine, as do its neighbors, this vessel pursues an uninterrupted course along the normal intestinal wall right on to the wall of the diverticulum, where it finally terminates in small branches.

The diverticulum is not flask shaped like the other specimens described, but its mouth is equal in width to its largest diameter.

SPECIMEN VIII.—The diverticulum opens from a portion of the small intestine resected at operation because of acute inflammation of its wall. There is some doubt as to whether it is ileal or jejunal. The case will be described in detail subsequently.

SPECIMEN X.—This was diagnosed roentgenologically (Fig. 10), and its presence confirmed at operation. It opened from the mesenteric aspect of the jejunum nine inches from the flexure. The wall was thinner than the normal intestinal wall, but no microscopic examination was made.

SPECIMEN VII.—This is unique, in that it is associated with a malignant growth of the bowel (Fig. 11). The diverticulum is situated on the mesenteric aspect of the jejunum, to the side of the mesentery, and possesses no muscle coat.

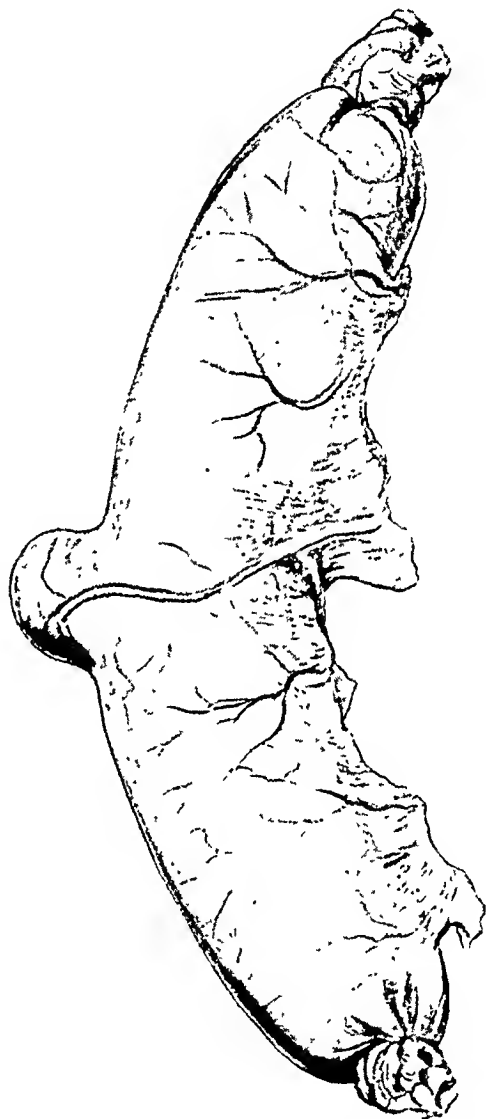


FIG. 9.—Solitary diverticulum of the jejunum. The specimen is unusual in that it arises from the antimesenteric aspect of the bowel. Note the large vessel associated with it.

SUMMARY OF THE MORBID ANATOMY

(1) Of a total of 12 cases from all sources, five are multiple and seven single.

(2) Specimens VII and VIII present unusual features, and will be considered separately.

(3) The diverticula of Specimens I, II, III, IV, V, VI and IX, and probably X, are herniae of the mucous membrane of the jejunum. There is no difference in morphology between the single and the multiple cases



FIG 10—Solitary diverticulum of the jejunum associated with a chronic gastric ulcer (position of pouch confirmed by inspection)

(4) The site of herniation of the mucous membrane through the wall of the intestine corresponds with the entry of the blood vessels.

(5) In all except one case, the diverticula are on the mesenteric aspect of the intestine. They do not, however, push between the leaves of the mesentery unless they are of large size, or fuse with a fellow from the opposite side of the mesentery. In the case of the diverticulum on the antimesenteric side of the intestine, the opening corresponds with a blood vessel of unusual size.

(6) The diverticula may carry with them during their formation a layer of muscle fibers from the muscular coat of the bowel. Such may form a thin but complete muscular coat for diverticula of small size, though it seems probable that if a section were examined which chanced to pass through the point on the fundus of the diverticulum which was the first to pass through the muscular coat of the bowel, no muscle fibers would be seen. In large diverticula, the fundus is completely devoid of a muscular coat. This is because it increases in size chiefly at the expense of the mucous membrane and submucosa, and eventually there is not sufficient muscular tissue in its



FIG. 11.—Solitary diverticulum of the jejunum associated with a new growth.

wall to “go round.” The latter is limited, therefore, to the walls at the commencement of the diverticulum.

Pathogenesis.—There is no room for doubt that the diverticula under discussion are acquired deformities of the bowel wall. Apart from the age incidence—diverticula of this type are unknown in the new born—their pathologic anatomy is to be explained only by the thesis that the pouches are herniae of the mucous membrane through the muscular wall of the intestine. If this view be accepted, the causal factors to be discussed are two.

(I) The presence of a weakened area—a locus minoris resistentiae—in the bowel wall.

(II) A pulsion force acting from within the bowel which initiates the process of herniation.

I. THE LOCUS MINORIS RESISTENTIAE

The constancy with which these diverticula are associated with the blood vessels refutes the possibility of coincidence. Furthermore, it has been shown in the analysis of Specimen I that the diverticula start just to one or the other side of the mesentery. As the following anatomic description shows, this coincides with the perforation of the muscularis by the blood vessels supplying the intestine.

The Anatomy and Rôle of the Blood Vessels.—Fig. 12 is an illustration

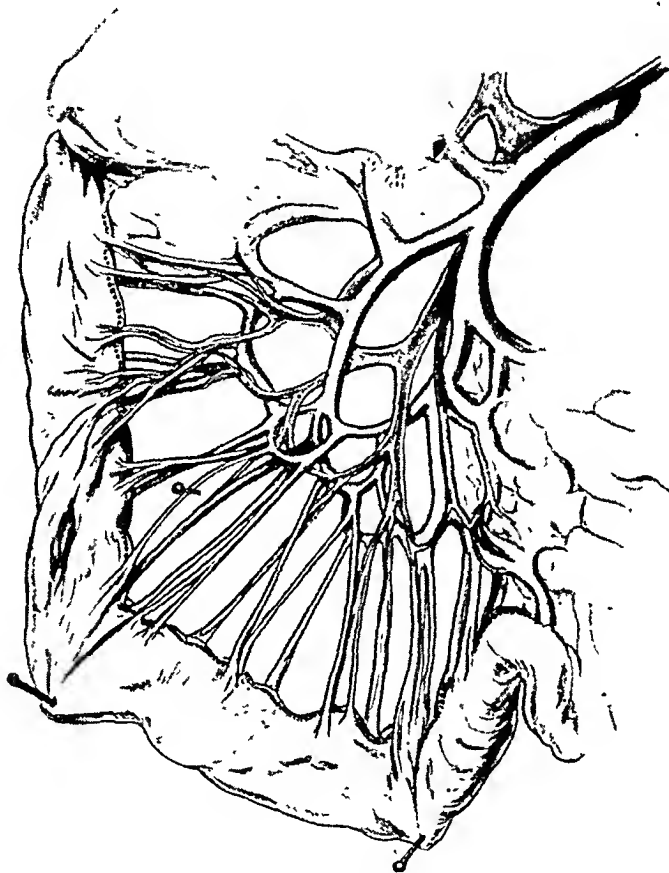


FIG. 12.—Dissection of the vascular supply of a segment of the jejunum. The midline is indicated by the interrupted line. The terminal vessels enter the bowel on either side of the midline.

made from a dissection of a segment of an adult jejunum, after injecting the superior mesenteric artery *in situ* in the dead body.

The mesentery and mesenteric fat have been cleaned off the vessels, and the artist has faithfully represented the extremely complex interrelation of the arteries and veins. One inch or more from the margin of the intestine the final series of arches is formed, and from these arches the segmental arteries pass to the intestinal wall.

The arteries pierce the intestinal wall in pairs and on either side of the mesenteric line, which is shown by the interrupted line in the illustration,

and a variable distance from it, but not more than three-sixteenths of an inch away.

In most cases the arteries of each pair are exactly opposite each other, but in some cases they alternate. There is, in other words, not a completely regular arrangement. When the arteries reach the wall of the intestine, on



FIG. 13.—Photomicrograph of a whole section of jejunum after injection of vessels with carmine jelly. Note how the artery and vein interrupt the muscularis just lateral to the midline.

either side of the mesenteric line, they disappear from view by piercing the muscular coat to reach the submucosa. Some fine twigs, omitted for the sake of clearness from the illustration, are given off before the main vessels pierce the muscular coat, and pass towards the antimesenteric border between the muscular and serous coats.

A cross section of an adjacent portion of the jejunum was now made to show the way in which the muscular coat is pierced by the blood vessels. Fig. 13 illustrates a low power photomicrographic section of this. The section passes through the long axis of one of the blood vessels as it pierces the muscular coat.

It will be noted that the blood vessel passes through both muscular coats a little distance from the mesenteric line, producing a well defined gap. The

entrance is at about 60° to the muscular coat so that the gap is not a very oblique one. *Practically the whole* of the blood supply to one-half of a segment of intestine is conveyed by this single vessel, which terminates in branches in the submucous coat. Some of these small branches are shown at the antimesenteric aspect of the bowel. They are somewhat distended as the result of injection under pressure. There are thus only two large gaps occasioned by the entry of the blood vessels of the jejunum in each segment, and those gaps are situated on either side of the mesentery, and a short distance from it (Fig. 14). The angle of penetration of the vessels, moreover, is such that the opening in the longitudinal coat is directly in line with that in the circular coat. Where any branches pierce the muscular wall farther away from the mesentery, not only are the gaps much smaller as the vessels are smaller, but the angle of penetration is far more oblique, and thus does not tend to create the same degree of weakness in the intestinal wall. The vessels of each segment are situated in most

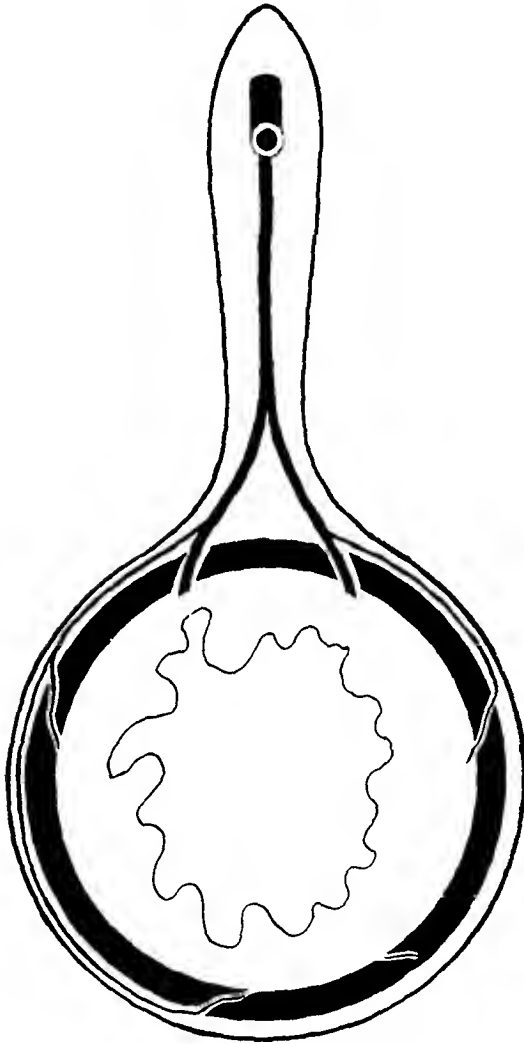


FIG. 14.—Diagrammatic representation of the mode of entry of the blood vessels through the muscular wall of the bowel.

instances opposite one another, but in others they alternate.

Thus we see that the origin of jejunal diverticula corresponds exactly with the point of entry of the blood vessels through the muscular coat. In only one instance in this series is this rule broken (Specimen VIII, Fig. 9), and in this there is an abnormality in the vascular supply, a very large vessel traversing the intestinal wall between the peritoneal and muscular coats and probably passing through the latter near the antimesenteric border, and producing a gap in the latter coat at this situation.

Thus the evidence that these diverticula are herniae of the mucous membrane through the muscular wall, at the point where a gap is caused in the latter by the entrance of the blood vessels, is indisputable.

One cannot leave this aspect of the subject without some reference to the work of Fischer. In general the author's conclusions are similar to Fischer's but the latter has made one or two additional observations from his own examination of the morbid anatomy of jejunal diverticula. He states that the circular muscle is the first to go and the outer coat remains intact for some time, but eventually becomes thinned as the diverticulum gets larger, and eventually disappears. This order, however, is not invariable. On occasion, the mucous membrane and inner circular layer pass through the longitudinal coat, and sometimes the break occurs in both circular and longitudinal cases simultaneously. Fischer does not think the diverticula always follow the blood vessel. Once started through the gap caused by a blood vessel, a pouch may track along the line of least resistance. He also states that in some cases there is thickening of the peritoneal covering of the diverticulum, which he interprets as nature's attempt to limit it.

In my mind it is questionable whether the blood vessels play any further part in the pathogenesis other than that of providing the locus minoris resistentiae. Klebs,¹⁸ however, believed that the mesentery increased in breadth in relation to the arteries, and therefore the latter dragged upon the submucous coat at their points of entry into the bowel, tending to pull it up through the muscularis. One frequently sees "festooning," as Craven has described it, of the small intestine wall at operation and postmortem. It may be due to the pull of the blood vessels, and it is a possible predisposing cause of herniation. It is unlikely, however, to play a major part in the process.

Sudsuki³² suggested in 1900 that the weak areas in the bowel wall are due to degeneration of the connective tissue sheath of the veins, so that an interval is created between the veins and the edges of the gap they caused in traversing the muscle coat. The theory is entirely speculative, and has no counterpart elsewhere in the body. Sudsuki appears to have offered this theory purely to replace that of Graser.¹² The latter suggested that the weak area in the muscular coat was produced by congestion of the veins draining the intestine, basing his conclusions chiefly on the finding that, in a postmortem series of pulsion diverticula of the large intestine, a number of the subjects suffered from chronic cardiac disease.

Perivascular infiltration of the muscle with fat has been suggested as a cause of the weak areas, but the author has found no suggestion of such a process in the specimens under review.

Some observers have suggested a myogenic cause, such as fatty degeneration (Roth), congenital hypoplasia (Buzzi⁹), senile atrophy (many workers), and a toxic myositis (Spriggs and Marxer³¹). The possibility that such degenerative processes are a cause is ruled out by the constancy with which these diverticula are situated in relation to the blood vessels.

II. THE PULSION FORCE

We are ignorant of the variation in pressure that must occur within the jejunum and ileum during life. Experimental evidence in animals obtained by placing balloons in a segment of the jejunum isolated by operation, and similar experiments upon the subjects of artificial jejunostomy, must be discounted for the following two reasons:

- (1) The conditions are abnormal in that a stoma is present.
- (2) The presence of an inflated balloon will provoke contractions in the musculature differing from any that are likely to arise spontaneously. Most of the results of this type of experiment record only the passive pressure possible to obtain by distension from within the intestine, and do not register the pressure excited by active contractions of the jejunal musculature under normal conditions.

The time honored name of jejunum is derived from the emptiness of this section of the intestinal tract found at postmortem. At operation the jejunum is collapsed and apparently empty, with a rugose and flaccid wall unless there be organic obstruction. Under normal conditions of segmental contraction and peristaltic movement the increase in pressure must be momentary and insignificant, for there is no bar at either end to the passage of the contents, such as the pylorus may furnish to the duodenum.

Can the passive force of the contents of the jejunum create a pressure sufficient to cause herniation? All writers appear to accept the view, first put forward by Klebs¹⁸ in 1896, that the pressure of fluid and gas in the jejunum is the initiating force of the diverticula. No intrajejunal tension under ordinary conditions can approach in power that present in acute small intestine obstruction. The tense, ballooned jejunum of organic obstruction is all too familiar to surgeons, but the condition never gives rise to hernial diverticula. The production of diverticula of the intestine by distending the dead bowel under pressure has frequently been attempted.

Thus Hanau¹⁵ filled a loop of intestine with water and by subjecting it to hydraulic pressure produced trench-like furrows along the mesenteric border before perforation occurred. Hansemann,¹⁶ by the same method, claims to have produced diverticula related to the blood vessels. These were obtained only when using intestines from old people. He failed with the intestines of children.

It cannot be too strongly emphasized, however, that experiments upon the dead intestine are entirely without value. The strength of the intestinal wall depends largely upon the strength of its muscular coat, and the essence of the strength of muscle lies in its power to contract.

Chlumsky has shown by experiment the fallacy of drawing conclusions from any distension experiments upon dead intestine. He found that by distending the small intestine of living dogs, rupture occurred on the convexity of the bowel, *i. e.*, the antimesenteric aspect, but that on distending

intestine removed from a dog ten hours after death, rupture occurred into the mesentery.

In the case of the living intestine, the coats yielded in the following order: (1) serous coat; (2) circular muscle fibers; (3) longitudinal muscle fibers; (4) mucous membrane.

Chlumsky adds that if tearing occurs in acute ileus, the peritoneal coat on the antimesenteric border of the bowel is the first part to yield.

In the light of clinical experience and Chlumsky's experimental results on the living animal, it can be stated without fear of contradiction that passive distension of the wall of the jejunum from pressure of its contents is not a factor in the causation of diverticula.

The unknown quantity in the production of intrajejunal pressure is the

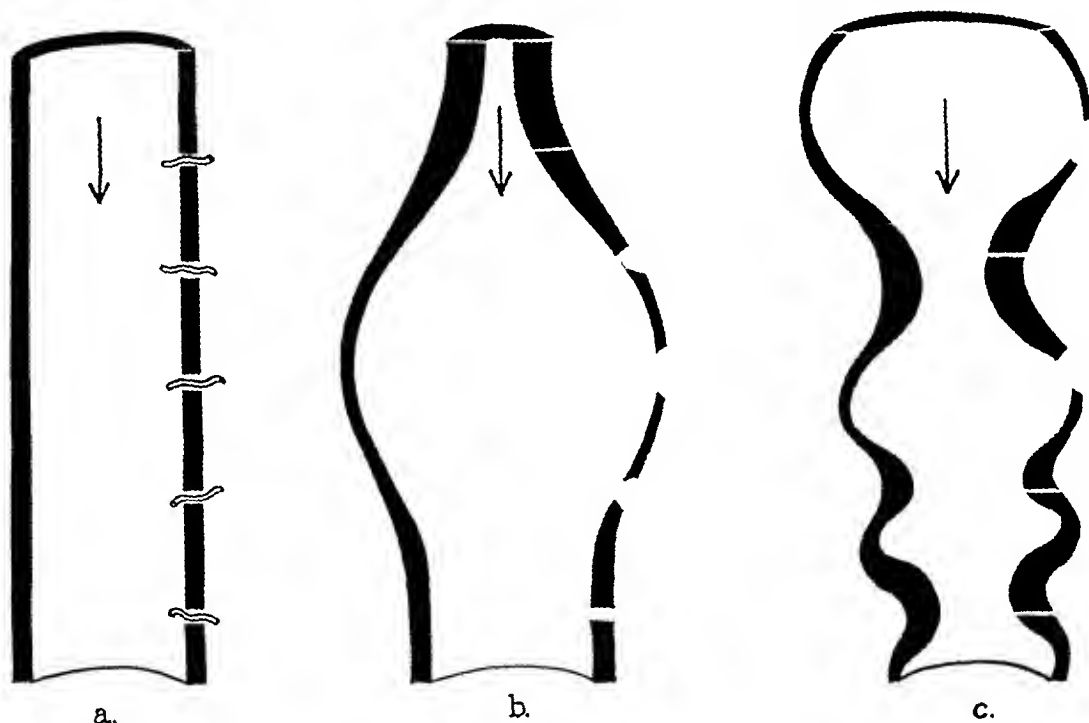


FIG. 15.—The mechanism of the formation of diverticula. Diagram illustrating normal contractions of the muscularis.

behavior of the muscular coat. Under normal conditions of contraction, as far as we understand them, a prolonged increased rise in pressure does not occur. One must postulate therefore some irregularity in muscular contraction. The better developed the muscular coat of the intestine, the more resistant the wall must be to passive pressure upon it. But if there is an irregular contraction of the muscular layers, so that one set of fibers is in spasm and the adjacent fibers are relaxed, a considerable alteration occurs from the normal both in the local pressure produced inside the lumen and the resistance of the wall to that pressure. Such local contractions and relaxations of the muscularis have been witnessed in the colon—anyone who stimulates the everted intestinal wall in a colostomy with prolapse will see them—and such a condition is therefore possible in the muscular coat of the small bowel.

Let us now examine the possible effects of regular and irregular contractions of the bowel's wall, as illustrated diagrammatically in Figs. 15 and 16. In Fig. 15 the muscular coat of the intestine is represented as a hollow tube, perforated at intervals for the passage of the blood vessels.

In Fig. 15 a peristaltic wave is suggested. The vascular gaps are narrowed in the contracting portion. During maximum contraction of the muscle, these gaps are temporarily obliterated, as they pass through two sets of muscle fibers contracting at right angles to one another. The peristaltic wave is preceded by a wave of relaxation. In this situation the vascular channels gape to their maximum extent, and constitute a very weak area in the bowel wall. Under normal conditions, however, there is no tendency for the mucous membrane to herniate through these areas, as the contents of the bowel are hurried along, and there can, therefore, be none but the most temporary rise of pressure inside the lumen of the bowel.

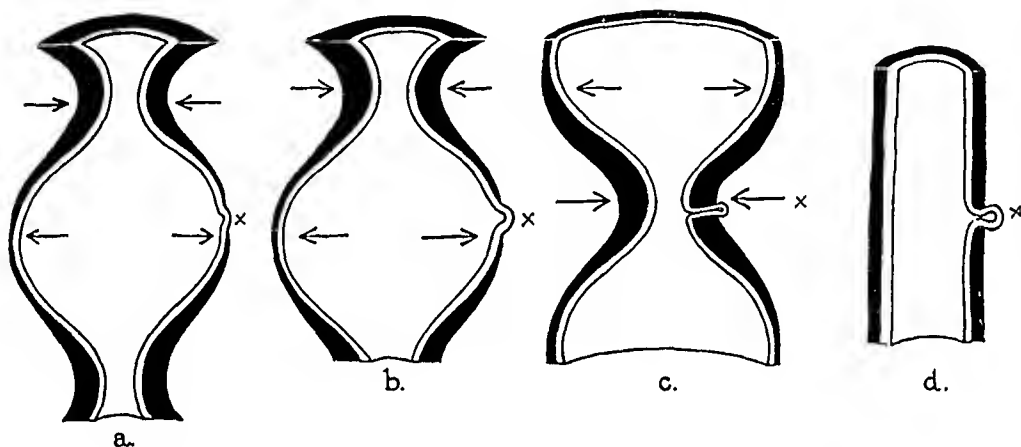


FIG. 16.—The mechanism of formation of diverticula. Diagram illustrating abnormal contraction of the muscularis.

If persistent irregular contraction of the bowel is present, then there may be considerable local increase in pressure. Such an irregular contraction is suggested in Fig. 16. Fixed spasm is occurring in two segments of the intestine, with the intervening segment relaxed (a). That spasm of the muscle to this extent can occur is shown roentgenologically in duodenal ulcer cases. As the contents are prevented from passing along the bowel, the pressure in the relaxed portion is increased, and the contents are being squeezed against the mucous coat, and tend to push between any interval that can be found between the muscle fibers. The vascular channels, gaping to their fullest in the relaxed muscle wall, offer the mucous membrane loci minoris resistentiae.

The probable stages in the formation of a diverticulum as a result of such persistent irregular contractions of the bowel are shown diagrammatically. A relaxed segment of the intestine lies between two contracted portions (a and b). As the result of the contraction, pressure is exerted upon the walls of the pockets. At (x) in the illustration, a vascular gap is suggested. As a result of the combination of increased pressure and

relaxation of the muscular wall, a wedge of mucous membrane is driven into the gap. If this part of the intestinal wall contracts, the wedge may be driven back, but there will come a time when the wedge driven out is of such size that the contraction of muscle about its base will consolidate its position by gripping it in the vascular gap (*c*). After many repetitions of this process, a permanent hernia of the mucous membrane will result (*d*). This will tend to increase in size purely as a result of the pressure inside the gut, for its wall is not supported by muscle, and will gradually be stretched by the constant pressure exerted upon it. It is difficult to say how long it takes for a diverticulum to develop to the size of those in the specimens described, but it is probably a matter of many years.

Diagnosis and Clinical Aspects.—The diagnosis of jejunal and ileal diverticula can be made only from roentgenologic examination, and then, usually, only if a residue of barium remains in the diverticulum after the jejunum has emptied. Contrary to the finding with regard to diverticula of the duodenum, jejunal diverticula are more frequently discovered at post-mortem examination, when they are not likely to be missed unless of small size.

Symptomatology.—In only four cases was a diagnosis of diverticulosis made, and the clinical histories of these are as follows:

CASE REPORTS

CASE I.—A man, aged 49 years, was operated upon in 1929. In 1923, he experienced pain in the epigastrium two and one-half hours after meals. The pain was in the nature of a dull ache, and was to the left of the midline, but the patient could not localize it exactly. The pain was liable to come in attacks with free intervals. He occasionally vomited during an attack. Flatulence was a marked feature, and its occurrence coincided with the onset of pain. The appetite was good, but lately the patient had been afraid to eat. He had been constipated for the last three years.

Barium meal and roentgenologic examination revealed a large diverticulum of the jejunum just beyond the duodenojejunal flexure. It remained full for 24 hours after the jejunum was empty.

At operation the diverticulum was readily found six inches from the flexure. It opened from the mesenteric aspect of the gut, and hung downwards. The mouth was considerably narrower than the maximum diameter of the diverticulum, so that the latter was almost pedunculated. No other abnormality was found that could explain the symptoms.

The diverticulum was excised, the stump inverted, and the intestine closed by a continuous suture of catgut. On account of the narrowing of the lumen of the intestine caused by this procedure, a posterior gastro-enterostomy was performed. In May, 1931, the patient declared himself well, and had no further attack of the epigastric pain and flatulence.

A microscopic section of the wall of the diverticulum at the fundus shows a complete absence of muscle fibers. The base of the diverticulum was of no use from the standpoint of microscopy owing to the trauma caused by a crushing clamp.

CASE II.—The patient is a man aged 69, first seen in November, 1930. Eighteen months ago he complained of pain in the lumbar region and slight pain of a vague character in the abdomen. At this time attacks of flatulence commenced, starting half an hour after meals and lasting from one to one and one-half hours. There was no nausea

or vomiting, and no loss of appetite or weight. He had been constipated for the last two to three months. The abdomen was distended without obvious cause. There was no tenderness but the left rectus appeared to be more spastic than the right. The benzidine test for occult blood was negative.

A barium meal and roentgenologic examination showed several moderate sized diverticula of the small intestine, best seen in the two hour film. Some of these remained filled four hours after the meal. There were also a few diverticula in the sigmoid.

The patient was not operated upon but was advised relative to regulation of bowels and diet. Seen six months later he appeared to be no better but still refused operation.

CASE III.—A man aged 67. For two years he had suffered vague epigastric pain, chiefly noticeable an hour or two after meals, and accompanied by marked flatulence. Belching appeared to relieve the pain. There was no nausea and no loss of appetite. He had been slightly constipated for many years.

Barium meal and roentgenologic examination showed the presence of two (? three) diverticula in the jejunum, best seen at two hours. There was no residue in them after the jejunum had emptied. Owing to age and general infirmity the patient was advised against operation.

CASE IV.—A woman, aged 38, had for six to eight years suffered from pain in the left hypochondrium. Flatulence occurred after meals to an extent which embarrassed the patient. She had suffered from constipation severely all her life. Roentgenologic examination showed the presence of several diverticula of the jejunum.

At operation, a segment of the upper jejunum was found to be somewhat dilated and the wall thickened as a result of hypertrophy of the muscular coat. Several diverticula were found on the mesenteric aspect. The length of bowel was resected (Fig. 5), and a side-to-side anastomosis made. Convalescence was satisfactory.

COMMENTARY.—The two outstanding symptoms common to these five cases are (1) vague abdominal pain, at an interval after meals, and (2) flatulence, corresponding in time incidence with the pain. That these symptoms can be definitely attributed to the presence of the diverticula is shown by the relief obtained from them after operation. They are probably due to retention of contents in the diverticulum and not to infection (diverticulitis). The one case in which acute diverticulitis was present will be described subsequently.

The literature provides a number of cases in which diverticulosis of the jejunum appears to have been responsible for symptoms. Tengwall³⁴ operated upon a woman of 51 who had many diverticula affecting the portion of the jejunum lying between a point 10 inches from the flexure and a point 30 inches below. They were diagnosed by roentgenologic examination before operation. The diverticula were situated on both sides of the mesenteric attachment, close to the mesentery but apart from it. The large ones showed depressions upon the surface as though composed of several diverticula of smaller size. He states that vague digestive disturbances with occasional nausea and irregularities of the bowel are usually met with in diverticulosis, but that the most common symptom is bleeding from the bowel. This latter statement is not borne out by the author's experience (but note the hematemesis in Braithwaite's⁶ case). Gordinier and Sampson (1906), in describing a case of acute obstruction in a woman of 45, in whom 13 diverticula were present, state that they cannot find a single case in the

literature in which clinical symptoms arise from pressure due to jejunal diverticula.

Mackechnie's case in a woman of 43 with 13 diverticula of the jejunum, suffered from increasing constipation and flatulence, abdominal pain and attacks of vomiting. There were also three diverticula present in the duodenum. Lambert and Surmont¹⁹ record a case of incomplete obstruction due to the presence of diverticula of the jejunum in a woman of 50. In Terry and Mugler's³⁵ case of a woman of 59, the early symptoms were due to a duodenal ulcer. In the 19 cases they review from the previous literature, only three gave symptoms.

Perhaps the most instructive case that has been recorded is that of Braithwaite.⁶ A man of 54 had suffered from attacks of indigestion for a period of some nine years. The chief features were vague pain after meals, flatulence and borborygmus. Vomiting occurred frequently, and on one occasion was followed by five pints of unaltered blood. At operation four feet of the upper part of the jejunum were found studded with diverticula. A short circuiting anastomosis was performed without relief, and four months later the segment of bowel was resected, and relief from all symptoms was obtained.

It must be admitted that the symptoms of jejunal diverticulosis are not sufficiently characteristic to warrant a diagnosis of diverticulosis on clinical grounds alone, and roentgenologic examination is the final criterion. Caution must be exercised in holding the presence of diverticula as responsible for abdominal symptoms, and all other possible causes should be eliminated. If the author's own cases be taken in conjunction with those in the literature, it will be seen that the most common clinical symptoms are those of a flatulent dyspepsia. There may be in addition signs of incomplete obstruction, *viz.*, distension of the upper and left segment of the abdomen, with visible peristalsis. In Braithwaite's case, the upper part of the jejunum was distended and its wall thickened from hypertrophy of the muscle. Chronic diverticulitis giving rise to the peptic ulcer type of pain does not appear to occur in jejunal diverticulosis as in duodenal cases, for there is not a single case in the literature with a clinical history of this type. In the author's case of acute diverticulitis to be described immediately, the diverticulum was probably not of the pulsion type.

Acute Diverticulitis of the Small Intestine.—The specimen illustrated in Fig. 17 was removed at operation upon a male aged 53, who suffered acute abdominal pain. It consists of a segment of the small intestine. The bowel has been opened along the anti-mesenteric border, and a black glass rod passed through the opening of a diverticulum, which can be seen in contact with the mesentery. The diverticulum is spherical in shape and appears to be at some little distance from the bowel wall, communicating with the bowel lumen by a narrow opening. It is situated chiefly to one side of the mesentery. The peritoneal covering of the diverticulum and the adjacent portion of the intestine, and the mesentery, is a deep plum color from extreme congestion, and has lost its normal sheen. The wall of the diverticulum and of the bowel in the neighborhood is thickened

as a result of acute inflammatory edema. This is most marked in the diverticulum, and can be seen at the edges of the window cut for microscopic section.

The mucous membrane of the intestine near the orifice of the pouch shows the same inflammatory change. The mucous membrane of the diverticulum cannot be seen grossly, but its fate is shown in the microscopic section. Pus was present in the diverticulum when it was removed.

The wall of the diverticulum consists mainly of two coats, submucosa and serosa. The mucous membrane has been completely destroyed, leaving exposed a submucous coat which is infiltrated with inflammatory cells. The serous coat is enormously thickened by inflammatory edema, and is similarly, though less intensely, infiltrated. Between these two coats is a thin layer of muscle. The fibers are not clearly defined from the muscular coat, owing to the acute inflammation.

Clinical History.—A man of 53 had been suffering acute central abdominal pain for 24 hours. The temperature was 98° and the pulse 80. There had been no vomiting, and

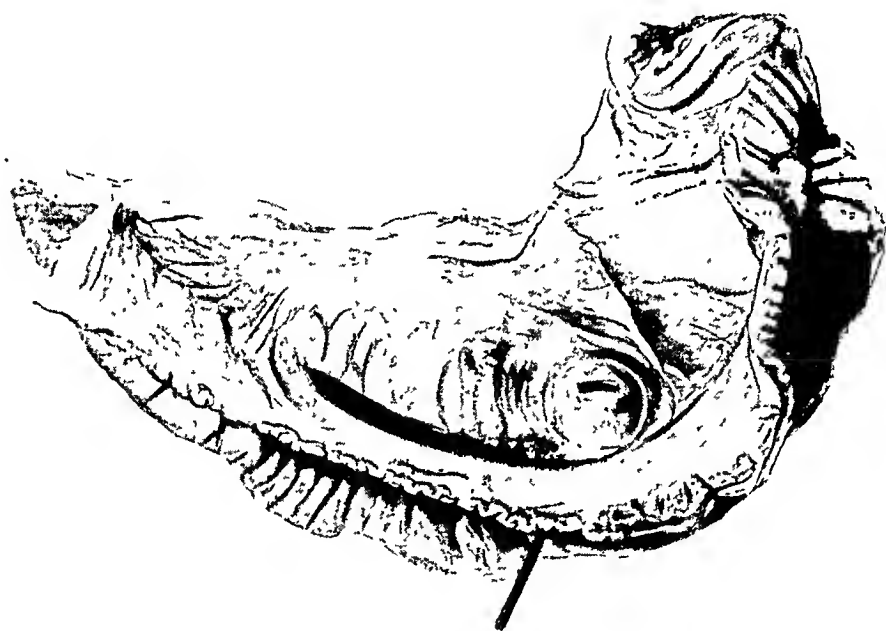


FIG. 17.—Acute diverticulitis occurring in a solitary diverticulum of the small intestine (? ileum). Operative specimen.

no previous history of indigestion. The bowels had been opened prior to the attack. The recti were tense, and tenderness was most marked immediately below the umbilicus.

Laparotomy revealed a normal appendix, and a mass the size of a man's fist towards the center of the abdomen. This consisted of adherent omentum and coils of small intestine. Separation of these structures showed an acutely inflamed diverticulum. Ten inches of the intestine containing the diverticulum were resected and an end-to-end anastomosis made. The patient made an excellent recovery.

The author is in some doubt as to the exact nature of this diverticulum. Unfortunately, during the emergency operation the exact site of the diverticulum was not noted, but it was at some distance from the ileocecal valve, and yet comparatively low down in the abdomen. Presumably, therefore, the portion of intestine resected is either from the lower end of the jejunum or the upper end of the ileum. This is an unusual situation for a diverticulum of the pulsion type. It is probably an example of a congenital diver-

ticulum of the cystic type, and the following arguments are put forward in favor of this view:

- (1) Its situation in an unusual position for a pulsion diverticulum.
- (2) It has a well defined, though thin, muscular coat at its fundus.
- (3) The diverticulum is almost a complete cyst, communicating with the lumen of the intestine by a very narrow opening.
- (4) It stands a little way away from the wall of the intestine.

Diverticulum of the Jejunum Associated with a Malignant Growth of the Jejunal Wall.—This unique case has no exact parallel in the literature. The nearest approach to it is the duodenal pouch accompanying a growth which Morrison and Feldman described. The specimen (Fig. 11) was obtained at postmortem upon a woman of 53 who died from malignant disease, and consists of a segment of the upper portion of the jejunum.

There is a solitary diverticulum lying in contact with the mesentery. The diverticulum and the portion of intestine with which it communicates have been freely opened. The pouch is flask shaped with a thin wall containing no muscularis at the fundus, and has a fairly wide mouth. Apart from its situation, entirely to one side of the mesentery, it resembles in appearance a typical jejunal pulsion diverticulum. The intestine above it is somewhat dilated.

The wall of the intestine surrounding the mouth of the diverticulum is thickened, and its cut surface has a dense white homogeneous appearance, replacing the demarcation between the layers of the bowel which normally can be seen on naked eye examination. The microscopic section shows the submucosa to be infiltrated with large cells of a carcinomatous type. There is no tendency towards any definite order in the arrangement of the cells. There is very little stroma or evidence of active karyokinesis.

Other similar deposits of growth were found in the retroperitoneal region, the mediastinum, the pericardium and the diaphragm. This was the only evidence, however, of growth in the intestinal wall. The site of origin of the primary growth could not be determined. It was originally diagnosed as an "endothelioma," but further examination leaves little doubt that the cells of the growth are epithelial in origin.

The Treatment of Jejunal Diverticulosis.—The foregoing account shows how rarely diverticula of the jejunum give rise to symptoms. Also, in those cases where symptoms do arise, how hopeless any attempt at medical treatment is likely to be. The only possible way in which relief of symptoms may be obtained is by operative measures. Although care must be exercised before attributing abdominal symptoms to the presence of diverticula of the jejunum demonstrated roentgenologically, operation upon them is a far simpler procedure than operation upon diverticula of the duodenum. The jejunum has a mesentery, and is therefore free, which fact, together with its great length, makes any plastic or resection operation a comparatively safe and easy procedure. Therefore there need not be the same hesitancy in advising the patient to submit to operation as is the case with diverticula of the duodenum.

Operative Procedure.—Here, in my opinion, the issue is much clearer than is the case with diverticula of the duodenum. The best procedure, whether the condition be multiple or confined to a single pouch, is resection of the affected portion of the gut and end-to-end or side-to-side anastomosis.

NOTE.—My thanks are due to the Council of the Royal College of Surgeons for permission to publish this article, and to Miss Mary Barclay Smith who is responsible for the illustrations.

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THE PROBLEM OF THE LOW SIGMOIDAL GROWTH

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WITHIN the past decade the surgical treatment of neoplasms situated in the mobile portion of the sigmoid and in the rectum has reached a degree of standardization comparable to present day surgery for malignancy of the breast. The operations now in vogue vary somewhat in technical details and in scope, but the fundamental principle of all of them may be traced to three classic procedures, namely, the exteriorization operations of Paul⁶ and Bloch¹ for sigmoidal lesions, the perineal excision of Allingham for low rectal and anal growths, and the radical combined abdominoperineal resection of Miles⁴ for high rectal and rectosigmoid malignancies.

The changes made in these basic procedures have been directed for the most part toward a more extensive removal of regional lymphatic structures and toward increasing the scope of usefulness of the radical operation of Miles through the employment of multiple stage maneuvers in the poorer risk patients. For example, the obstructive resection (Rankin⁷), which is based on the early exteriorization measures, embodies the desirable features of the latter yet avoids the disadvantages, principally through immediate excision of the involved segment of bowel over a clamp devised for the purpose, thus permitting the removal of a greater expanse of mesentery without sacrifice of blood supply to the remaining parts. Moreover, the mortality both immediate, and remote, from metastasis, has been materially reduced by this procedure. In like manner, due chiefly to the efforts of Mummery,⁵ the perineal excision has been changed from a purely palliative procedure to one of distinct usefulness in the cure of low rectal growths. He demonstrated that the peritoneum may be opened posteriorly and a considerable portion of the sigmoid with its vascular and lymphatic structures be excised without augmentation of the mortality. The combined operation of Miles, after more than a score of years, remains the undisputed ideal in the radical extirpation of cancers of the rectum and rectosigmoid. In the better risks and in the hands of surgeons highly skilled in such procedures, the one stage combined operation is still indicated but if all patients afflicted with carcinoma of the rectum and rectosigmoid were so treated the mortality would become prohibitive. Alternative measures based upon the surgical principles of Miles' operation have been proposed by various men with the modification that the operation be done in two or more stages. Jones,² of Boston, for many years has done a radical graded operation after a loop colostomy. One of us (Rankin⁸)

modified Miles' operation in 1928 to a two stage procedure, and the following year Lahey³ modified this operation still further by bringing the upper end of the rectal segment out of the lower end of the abdominal wound to be utilized for irrigation.

Neoplasms situated low in the sigmoid constitute a separate problem. They cannot be exteriorized without extensive mobilization of the rectosigmoid hence they are, as a rule, subjected to an abdominoperineal operation of some type. From the standpoint of curing the disease, such a course is entirely satisfactory but unquestionably there are instances in which a more conservative procedure, without sacrifice of the rectum, is justifiable. Our own indications for carrying out an anterior resection, of the obstructive type, with subsequent restoration of the bowel continuity are as follows: (1) small growths uncomplicated by infection; (2) growths of a low grade of malignancy, as determined by biopsy through the sigmoidoscope; (3) polypoid growths of doubtful benignancy; and (4) refusal of permanent colostomy. Unfortunately there are, not infrequently, factors present which make such a procedure inadvisable. Chief among these is a marked inflammatory reaction or abscess formation in the vicinity of the lesion, and instances of a short sigmoid flexure.

About a decade ago we became interested in anterior resection for selected cases of cancer of the rectosigmoid, but at first no attempt was made to reunite the divided ends of bowel. In this procedure a colostomy was established high in the sigmoid and at a subsequent operation the sigmoid, distal to the colostomy stoma and the rectosigmoid, were resected, the divided end of rectum inverted, and a new pelvic floor established. Our object at that time was to avoid the rather high mortality incident to the abdominoperineal operation and the morbidity which accompanies excision of the rectum. We felt then as we do now that the lymphatic structures draining the segment of bowel under consideration could be removed in a sufficiently radical manner by such a procedure in instances of early, low grade malignancy. In 1928, 26 consecutive cases were reported with but one death. However, in three instances failure in the blood supply to the inverted and retroperitonealized upper portion of the rectum necessitated removal of the rectal stump several days after the anterior resection. It was because of this uncertainty in the blood supply that we determined for growths situated in the rectosigmoid, below the peritoneal fold, that a combined maneuver would be more appropriate. For the low sigmoid growths we continued to employ a modification of the anterior operation in those cases in which there existed a long segment of sigmoid distal to the inguinal colostomy. Several weeks after establishment of the latter the involved portion of bowel was resected and the divided ends rejoined. At a little later period, in some of the cases, we applied the principle of exteriorization and in more recent years have utilized this method with increasing frequency and favor. This procedure, to which the term obstructive resection was applied by Rankin⁹ in 1925, originally was employed for lesions affecting freely mobile segments of the colon, such as the transverse

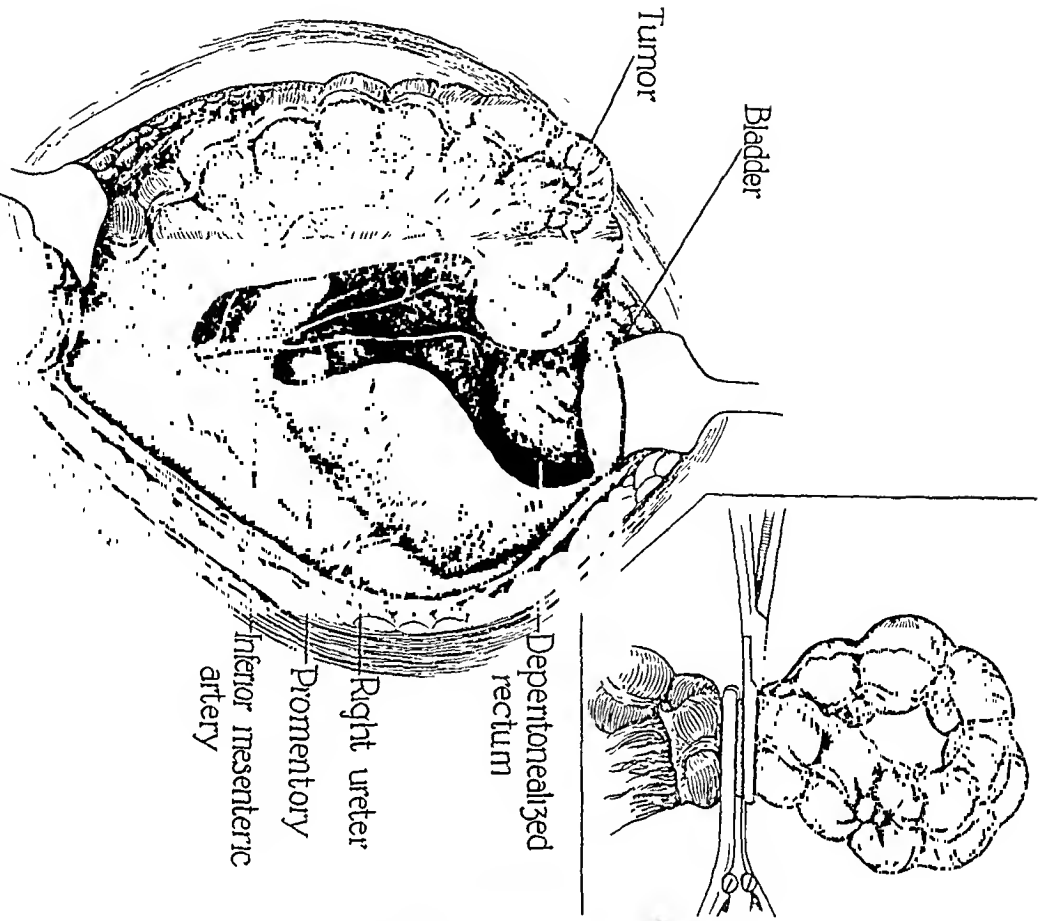


FIG. 1.—Involved segment of sigmoid elevated several inches above its original position following division of peritoneal attachments of bowel and blunt dissection of rectum from hollow of sacrum. Point of ligation of sigmoid artery indicated. (Insert.) Rankin clamp applied to two limbs of sigmoid; the exteriorized portion to be removed with a canter.

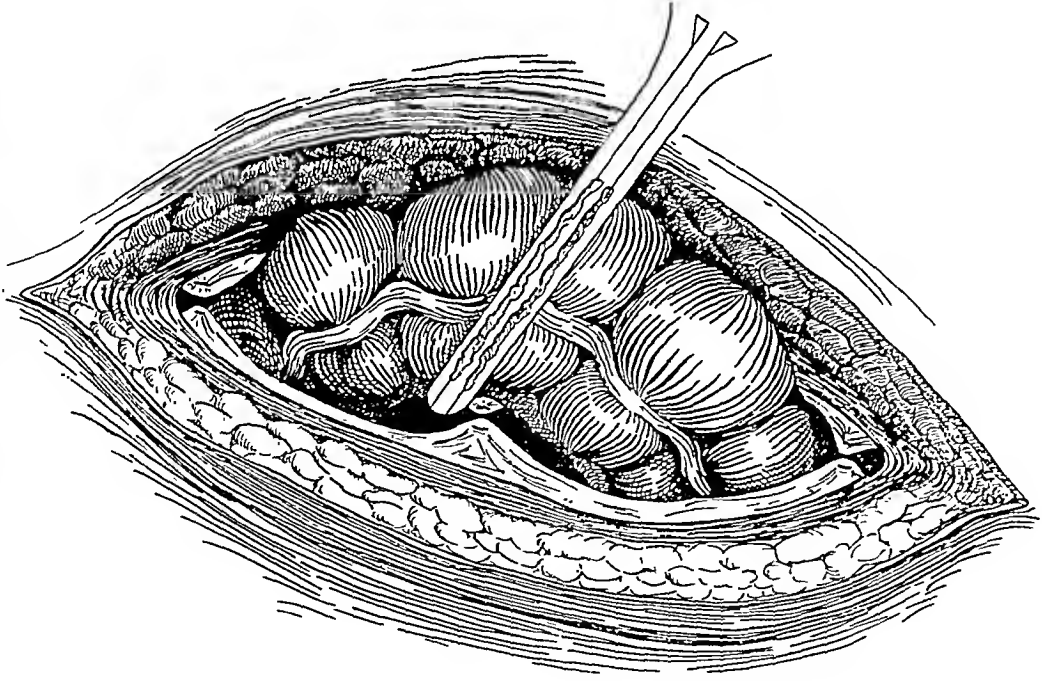


FIG. 2.—The peritoneum is brought under the loop and is sutured snugly around on all sides; sutures are not placed in the wall of the bowel.

colon and the midportion of the sigmoid. In the beginning two hemostats, or Payr clamps, were used to obstruct the bowel, but later a special three bladed clamp was devised with which to consummate the operation. This refinement in the technic was reported in 1929.

Our procedure varies little from that recently reported by David in which he applied the principle of obstructive resection to growths at the rectosigmoid.

Technic.—An incision is made low in the left rectus, or in the midline, after which the table is adjusted to the Trendelenburg position. Having packed off the small bowel in the upper abdomen, the sigmoid is isolated, and an incision made in the peritoneum of its mesentery on either side, from the base of the inferior mesenteric vessels forward to the bladder (Fig. 1). The sigmoid arteries, near their point of origin, are now ligated, care being taken at this time to identify the ureters, particularly the left. At this stage we have on several occasions ligated the superior hemorrhoidal artery without interference with the circulation to the divided ends of the sigmoid. We, believe, however, that this should not be practiced routinely since the collateral circulation through the middle hemorrhoidal arteries is not always adequate. Elevating the bowel, the hand is carried behind the intact superior hemorrhoidal artery, downward and forward into the hollow of the sacrum as far as the tip of the coccyx and in such manner by blunt dissection free all the tissue, including fat and lymphatic vessels in this region. The lateral incisions are now extended forward and the peritoneal attachments holding the bowel to the bladder are divided with scissors; here further blunt dissection completely frees the bowel anteriorly. There is seldom any bleeding of consequence following this dissection, but a hot pack placed in the pelvis will stop any venous oozing. It is now possible in most instances to lift the segment of bowel containing the growth outside the abdomen. This elevation of the growth, some 7 to 10 centimeters above its original position, is made possible by a combination of two factors, namely, division of the attachments at the rectosigmoid, and change in the shape of the rectum from a somewhat fusiform structure to a tubular one by virtue of the pull exerted on it in exteriorizing the growth (Fig. 1). The tendency of this diminution in the diameter of the rectum is to cause a desire for frequent defecation but in a relatively short period of time this sensation is overcome.

The next step is to excise a sufficient expanse of mesentery to insure removal of all lymphatic structures which might possibly drain the involved area. The special three bladed clamp (Rankin¹¹) is then applied to the limbs of bowel proximal and distal to the growth, care being taken to insure good blood supply to the two ends of the bowel. In applying the clamp the handle should be toward the median line in order that subsequently the clamp may rest on the abdomen. Just anterior to this clamp another is placed, including both arms of the loop of bowel, and between these clamps the bowel is divided with a cautery (Fig. 1, insert). The rent in the mesentery is closed without putting sutures into the bowel. A new pelvic floor is constructed at a somewhat higher plane, about on a level with the promontory of the sacrum, in

not hesitate to leave the end of the clamp, grasping the bowel ends, deep in the wound. In such cases, however, iodoform gauze is wrapped around the bowel, beneath the clamp so as to avoid contamination in case of leakage. Noting that when the bowel ends were thus left deeply placed, beneath the muscles, spontaneous closure occurred in almost every instance following destruction of the colostomy spur, we have adopted this technic even in instances of growths situated in readily mobilizable portions of the bowel. At the selected time, the proximal blade of the clamp is opened, but the distal blade is left closed and the clamp is not removed; the clamp is permitted to drop off and this usually occurs about the seventh day after operation. Rather

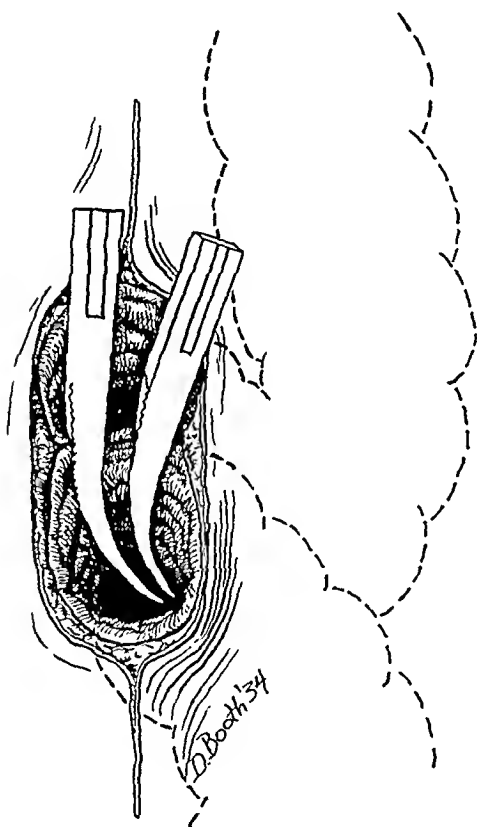


FIG. 4.—After the clamp has been removed and the wound is healed the spur is cut out of the two "gunbarrels" by application of clamps which effect a slow necrosis.

than tease open the agglutinated proximal end of the bowel on release of the blade it is better to allow the distention from pressure of gas within the colon to blow it open. The remainder of the operation is accomplished in a manner similar to that employed in the old exteriorization procedures; that is, the spur is cut out gradually with an enterotome, or with ordinary curved forceps, which are applied usually not earlier than two weeks or until the edema and inflammation commonly noted in the vicinity of the spur have disappeared (Fig. 4). After the lapse of a month or so the fistula is closed surgically, if necessary. In consequence of blunt dissection carried out in the hollow of the sacrum it has seemed advisable in most instances to institute drainage beside the rectum by introducing rubber tubing through a stab wound made just beneath the coccyx.

When it seems advisable, a cecostomy is established ten days to two weeks before the obstructive resection is performed. This necessity, however, has not often presented itself, for less than 10 per cent of the cases, numbering over 100, have been acutely obstructed, while in well over 90 per cent of cases it has been possible to adequately decompress the chronically obstructed bowel by a regimen that consists of initial purgation, repeated colonic irrigations, and an essentially non-residue diet. Strict avoidance of oral administration of barium in conjunction with roentgenoscopic examination of the intestinal tract when an obstructive lesion of the colon is suspected, has, we believe, reduced materially the necessity of preliminary cecostomy in our cases, for unquestionably such a practice is responsible for many instances of acute obstruction, superimposed upon a

chronic obstruction of long standing. Distention in these cases, even when the bowel has been left totally obstructed for 72 hours, has been of rare occurrence.

We fully recognize the tremendous value of preliminary cecostomy as an adjunct to surgery of the left half of the colon and rectum and believe that its employment is invariably demanded in the following instances: (1) acute obstruction; (2) chronic obstruction unrelieved by medical measures; and (3) resection of the left half of the colon followed by immediate anastomosis. Occasionally we also have availed ourselves of this measure in conjunction with the one stage combined abdominoperineal operations, even in the absence of obstruction.

The advantages of cecostomy as a measure preliminary to interval operations on the large intestines are manifold. Whipple,¹² in advocating its more frequent employment in such instances, has lucidly described these advantages as follows:

- (1) It makes possible a proper cleansing of the colon before the major procedure.
- (2) It permits the part anastomosed to be at rest until the period of fibroplasia is complete.
- (3) It increases the comfort of the patient by reducing distention and pains of ineffectual peristalsis.
- (4) It obviates the temptation and necessity in some cases of giving enemas or irrigations in the critical period of repair.
- (5) In cases of partial or complete obstruction of the colon or rectum it has long been recognized as essential. If it works well in the patients who are desperately sick, it is even more efficacious in the non-obstructed case.

The necessity for preliminary cecostomy is diminished in a procedure such as obstructive resection, because the bowel continuity is not immediately restored after excision of the segment of colon that harbors the growth, the two ends of which are safely held in position by the two bladed clamp during the "critical period of healing" that takes place between the peritoneum and the bowel. On the other hand, it is usually indicated when the traditional Mikulicz exteriorization procedure is employed because decompression of the bowel by cecostomy permits edema of the extended limbs of colon to subside before the latter are excised.

A highly laudable proposition, that all cancers should be eradicated in the most radical manner possible is, unfortunately, not always practical. Many qualifying factors determine the feasibility of a given operative procedure. Among these may be listed age, sex, general condition of the patient, presence or absence of concurrent disease in other organs, relative degree of malignancy as determined by Broder's¹⁰ index of malignancy, the age of the growth and extent of local lymphatic involvement and finally the skill and experience of the individual surgeon. Unquestionably it would be a mistake for every

patient with cancer of the rectum or rectosigmoid to be subjected to the operation of Miles or any other single procedure; and this holds equally true of the low sigmoidal growth. Nor should we base our selection entirely on the operative mortality and recurrence rate of a few surgeons whose experience with certain maneuvers is considerable. Given 100 cases of cancer of the rectum, one surgeon employing a less radical procedure may well have at the end of five years a larger number of patients living than another surgeon who has executed the most radical resection possible in each instance in a similar number of cases. Although we are convinced that the procedure here described may be advantageously employed in certain carefully selected cases, we do not lose sight of the fact that even in instances of a low sigmoidal growth the ideal procedure, in the absence of contra-indications, is the combined abdominoperineal operation.

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CARCINOMA OF LINITIS PLASTICA TYPE INVOLVING THE INTESTINE*

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THE term "linitis plastica" is now generally considered to designate a carcinomatous process in which the stomach is more or less diffusely contracted and has thickened and relatively inflexible walls. Available data, however, it seems, do not preclude the possible occurrence, rarely, of a benign inflammatory form of the disease. It appears that Liéutaud, in 1779, may have recognized the condition; however, credit for reporting the first case is usually given to Andral. Since Andral described the condition as a simple type of hypertrophy, in 1829, some 42 names have been ascribed to the lesion (Howard¹³). Brinton,⁵ in 1865, called it linitis plastica (Greek meaning linen cloth or net; Latin, *ex lino factum*), because of the network arrangement of the connective tissue in the gastric submucosa. Despite the fact that Brinton considered the lesion benign, and despite the merit of the criticisms of the term, it has persisted to date as the most generally used name for the condition. For this, if for no other reason, we feel that we are probably justified in its use to facilitate discussion herewith. The term "leather-bottle stomach" (Stretton,²³ 1909), also frequently used, is hardly appropriate for extragastric manifestations of this affection.

Although linitis plastica confined to the stomach is known to occur not infrequently, relatively few cases of this process occurring in the intestine have been cited. Coe,⁷ in 1931, reporting a case in which there was involvement of both flexures of the colon and of the rectum, stated that he had seen no other similar cases reported in textbooks or in the radiologic literature. We have, however, in a search of the general literature pertaining to the subject, encountered reports of 37 cases in which there was involvement of one or more portions of the intestinal tract. In only one of these, the primary coexistence of the gastric lesion apparently was not noted. This was a case reported by David,⁹ in which the rectum was involved, and it was not stated that the stomach was examined. Our series includes six cases of linitis plastica involving the intestinal tract, obtained from the files of the Mayo Clinic.

CASE REPORTS

CASE I.—A man, aged 34 years, came to the clinic because of stomach trouble of 12 years' duration. He gave a history of epigastric distress, coming on two hours after

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meals, which at first had been relieved by taking soda. As time went on, the distress had become more constant and had been accompanied by vomiting. The vomiting had increased in frequency until the time of the patient's admission to the hospital. On examination, the abdomen was found to be distended. Analysis of gastric content revealed total acidity of 50 and free hydrochloric acid of 30 (Töpfer's method); the total quantity of gastric content recovered measured 450 cc. The concentration of hemoglobin was 73 per cent. The Wassermann reaction was negative and results of roentgenologic examination of the stomach appeared to be negative.

Despite the lack of positive roentgenologic evidence, the patient's persistent symptoms of pyloric obstruction warranted operation, it was felt, and exploration was performed. This revealed diffuse thickening of the pyloric end of the stomach, of the second portion of the duodenum, and of the first six inches (15 cm.) of the jejunum. Gastro-enterostomy was performed. The patient is living today, 11 years after operation. He writes that he still has some stomach trouble.

CASE II.—A woman, aged 42 years, complained of a "filled-up" sensation in the stomach, of 16 months' duration. The distress usually occurred half an hour before meals and was relieved by vomiting. She said she felt most nearly well when eating small amounts of soft food. Her appetite was normal and her bowels moved regularly. She had lost 14 pounds (6.5 Kg.). Analysis of gastric contents revealed total acidity of 26, free hydrochloric acid of 8, and a total quantity of 50 cc. The Wassermann reaction of the blood and of the spinal fluid was negative. The concentration of hemoglobin was 64 per cent. The roentgenologic diagnosis was a lesion of the middle third of the stomach, possibly gastric syphilis. Other findings were irrelevant.

At exploration, an inoperable, diffuse carcinoma of linitis plastica type, involving the stomach and the central portion of the transverse colon, was found. The patient died one month and a half postoperatively, after leaving the hospital.

CASE III.—A woman, aged 52 years, entered the clinic because of abdominal distress of seven weeks' duration. She complained of abdominal pain which was most marked in the right lower quadrant, vomiting with gradual inability to take solid foods, and diarrhea. The abdomen was distended and tender. The value for hemoglobin was 75 per cent, and erythrocytes numbered 6,790,000 per cubic millimeter. The high count was probably attributable to concentration of blood incident to dehydration. Analysis of gastric content and roentgenologic examination of the stomach were not made because of the obvious intestinal obstruction.

Palliative ileosigmoidostomy was performed for what appeared to be a diffuse carcinoma involving most of the colon. The patient died one week after operation. Post-mortem examination revealed a carcinoma, Grade 4, of linitis plastica type, involving the entire stomach to within 2 cm. of the pylorus. The identical type of lesion produced a number of constrictions in the small intestine, causing obstruction, in addition to diffuse thickening of the entire colon. The esophagus, right oviduct, and peritoneum were also involved.

CASE IV.—A man, aged 50 years, complained of nausea and vomiting occurring after meals. His appetite was normal, but he was afraid to eat because of the resultant distress. The discomfort was relieved by vomiting. He had lost 15 to 20 pounds (7 to 9 Kg.) and appeared considerably emaciated. An epigastric mass was palpable. Analysis of gastric contents revealed total acidity of 60, free hydrochloric acid of 40, and a total quantity of 2,080 cc. The concentration of hemoglobin was 71 per cent. The Wassermann reaction of the blood was negative. Roentgenologic examination revealed a carcinoma of the pyloric end of the stomach, with retention and enormous dilatation.

Exploration revealed diffuse thickening of the entire stomach, and pyloric obstruction. A palliative gastrectomy and posterior Pólya anastomosis were performed. The patient died two months after operation. Post-mortem examination revealed a linitis plastica type of carcinoma involving what remained of the stomach. The colon, rectum,

jejunum and bladder were likewise involved. The contributory cause of death was a pulmonary embolism.

CASE V.—A man, aged 49 years, complained of persistent vomiting and loss of appetite of three months' duration. His strength had failed and he had lost 16 pounds (7 Kg.). An epigastric mass was palpable. Analysis of gastric content revealed total acidity of five, no free hydrochloric acid, and a total quantity of 275 cc. Roentgenologic examination of the stomach gave evidence of a carcinoma involving the pyloric region.

Exploration revealed an inoperable carcinoma of the stomach, head of the pancreas and common bile duct. The patient died two months after operation. Postmortem examination revealed a carcinoma of linitis plastica type involving the stomach, transverse colon, mesentery, peritoneum, appendix, lymph nodes, pancreas, and ureters.

CASE VI.—A woman, aged 50 years, entered the clinic because of intestinal obstruction. She gave a history of stomach trouble of two and one-half years' duration. Her appetite had been poor. She was nauseated after eating. Prior to the onset of her trouble,



FIG. 1.—(Case VI.) Typical linitis plastica of stomach. A diffuse, fibrous type of thickening of the gastric wall is evident.



FIG. 2.—A type of lesion identical with that represented in Fig. 1, involving the splenic flexure of the colon. Huge dilatation of the ascending colon is present.

she had received roentgenologic treatments for a fibroid uterus. A roentgenogram, made elsewhere a year before, was said to give evidence of pyloric obstruction. For two weeks she vomited almost continually and had intermittent abdominal cramps. She had had no bowel movement for one week. She was emaciated, having lost some 35 pounds (16 Kg.) since the onset of her illness. Abdominal distention was marked. Active peristalsis of the small bowel was visible. Other findings were irrelevant. Roentgenograms were not taken.

A clinical diagnosis of intestinal obstruction of the lower part of the ileum or the colon was made. Transnasal duodenal suction was instituted and solution of sodium chloride and glucose was administered by vein for several days preparatory to operation. The patient's general condition improved and the blood chlorides were brought up to 611 mg. per 100 cc.; then exploration was made. Operation revealed two constrictions of the colon, at the hepatic and splenic flexures, appearing to be about two inches (5 cm.) in length. The ascending colon and ileum were markedly dilated. The stomach was thickened but the prominent gross pathologic change was of the colon. Palliative ileocolostomy was performed to relieve the obstruction. The patient died of peritonitis on the ninth postoperative day. Postmortem examination revealed a linitis plastica type of carcinoma involving the entire stomach, the hepatic and splenic flexures of the colon as described, the esophagus, and the ileum. Microscopic examination revealed involvement

of the ascending colon, bladder, perirenal fat and diaphragm; involvement of these structures was not grossly evident (Figs. 1, 2, 3 and 4).

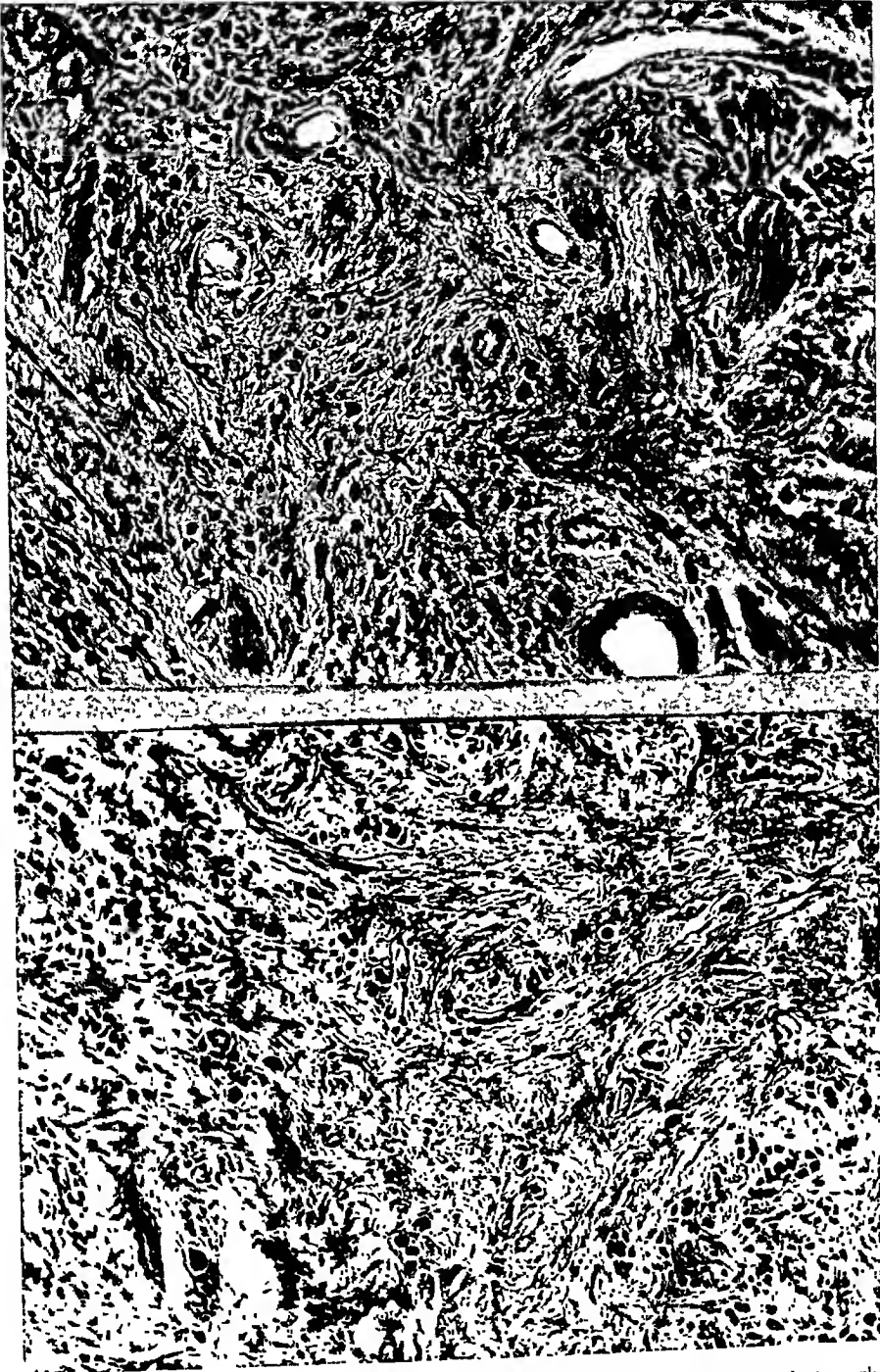


FIG. 3.—(Case VI.) Typical histopathologic section of gross specimen of stomach represented in Fig. 1. The so called network arrangement of connective tissue, with interspersed malignant cells, may be noted.

FIG. 4.—(Case VI.) Section taken from gross specimen of colon represented in Fig. 2. The pathologic change is obviously the same as that in the stomach represented in Fig. 3.

CRITIQUE OF CASES

Five cases of our group were encountered in reviewing 235 explorations in which linitis plastica of the stomach was diagnosed. This represents the total

number of such cases diagnosed in more than 11,000 exploratory operations on the stomach. Four cases came to necropsy and represent the number of times intestinal involvement occurred in 36 cases of carcinoma of the linitis plastica type encountered in some 4,000 routine postmortem examinations. The proportionately greater frequency of intestinal linitis plastica, postmortem, in our group of cases is probably accounted for by two factors: namely, the patients are seen later and therefore metastasis would be more likely to be present, and, examination of the viscera at operation is more difficult than at the necropsy table. This suggests that probably a relatively greater number of cases exist, in which there is intestinal involvement, than we are now aware of. In all of the four cases in which postmortem examination was performed, death occurred in the immediate postoperative period; three are included in the five surgical cases, but one is not, for the gastric lesion was not discovered at operation (Case III).

Unusual Manifestations.—The patient of Case III, as well as the one on whom we operated, came to operation because of symptoms of intestinal obstruction which were so prominent that what gastric symptoms were present, if any, were masked.

Some question may be raised as to the authenticity of Case I, as unfortunately we have no sections of the lesion. However, at operation the diagnosis of linitis plastica was made, and after carefully studying the case it seemed to present the characteristics of this condition. We are at a loss in attempting to place it in any other group. Aside from the unique situation of the lesion, this case is of especial interest in view of the fact that the patient is still living 11 years after operation. Other more bizarre situations in which what appeared to be linitis plastica was present have been recorded. Weber²⁵ reported a case in which the primary pathologic change seemed to be in the gallbladder, without evident involvement of the stomach, and Albot and Michaux,¹ a case in which acanthosis nigricans was present.

Ages.—The ages of the patients in this series ranged from 34 to 52 years. The average age was 46 years. Only one of the patients was less than 42 years of age. The ages of patients who had linitis plastica (not confined to those who had intestinal involvement) whose cases are reported in the literature have been somewhat higher than those of our patients. The average age of Lyons' patients was 52 years. Friedewald and Morrison's¹¹ ranged in age from 26 to 56 years; Baumgartner, Case and Deegan's² from 20 to 80 years, and Lyle's¹⁶ from 40 to 60 years.

Sex.—Of our patients who had linitis plastica involving the intestine, three were men and three were women. The authors mentioned in the foregoing paragraph reported that linitis plastica occurred about twice as often among men as among women in their cases.

Situation.—In all of our cases the primary lesion was found in the stomach. In one case the duodenum was involved throughout its second part. The small intestine, exclusive of the duodenum, was involved in five cases and the colon in five cases. There was a typical lesion of the rectum in one case.

In four cases multiple metastatic growths, of linitis plastica type, were demonstrable, exclusive of the involvement of the large and small bowel. These lesions were present in the diaphragm, pancreas, perirenal fat, esophagus, appendix, peritoneum, omentum, mesentery, fallopian tube, uterus and bladder. The situation of the lesions in our series of cases corresponds roughly to that of those we have found reported in the literature.

Pathology.—Although divergent views have existed as to the nature of the pathologic change in linitis plastica, it is now generally conceded that it is a malignant condition. Wyard²⁰ went so far as to say that it is a gross entity only and that a number of conditions may cause leather-bottle stomach. Brinton⁵ wrote that the lesion was inflammatory, although it seems he was not sure of this. Krompecher¹⁵ and Curtis⁸ expressed the belief that it is a form of gastro-intestinal sclerostenosis, and Pauchet,²⁰ Bensuade, Rivet and Lewald,⁴ Holmes and Ruggles,¹² and others, gave as their belief that some of the lesions are syphilitic. The weight of evidence now indicates that linitis plastica is a small cell carcinoma (MacCarty¹⁸). Broders⁶ likewise feels that so called linitis plastica is an adenocarcinoma and that it is merely one of the scirrhus type which has a peculiar tendency to form an excessive amount of fibrous tissue. Ewing¹⁰ concluded that it is a peculiar form of gastric carcinoma with cells of limited capacity for growth, occurring in a resistant subject. These factors, he maintained, tended to spontaneous regression of the tumor process. He expressed the belief that the rare cases in which the patients recover after gastro-enterostomy represent such spontaneous recovery. The patient who survived after exploration in our group (Case I) may fall into such a category, although we cannot prove that in this case the growth was not benign.

The pathology of linitis plastica involving the intestine is, obviously, essentially the same as that of the stomach. Grossly the bowel, as the other involved organs, appears waxy, lusterless, and pale because of disturbance of the blood supply attributable to perivascular fibrosis. The intestinal wall is diffusely thickened and relatively inflexible, which produces varying degrees of contraction of the lumen. Sectioning the bowel gives the sensation of cutting gristle. The mucosa may be destroyed or may appear intact. Ulceration did not occur in any of our cases, although it is occasionally present in the gastric lesions (Lyons¹⁷). The extent of involvement ranged from narrow, discrete, annular constrictions of the bowel to involvement of numerous portions of the small intestine and thickening of the entire colon.

Microscopically the fibrous tissue characteristically arranges itself in more or less of a network and this, as has been mentioned by others, is most marked in the submucosa, although all layers of the stomach or intestinal wall may be involved. Scattered among the areas of fibrosis are cancer cells with large nuclei which are often vesicular in appearance. At times signet ring forms are evident. The number of mitotic figures varies according to the degree of malignancy. In the experience of Broders, most carcinomas of this type are of high grade of malignancy. In Case III of our series the lesion was Graded 4, according to Broders' index of malignancy. The cancer cells may be numer-

ous and may be in definite glandular arrangement, or they may be so obliterated by fibrosis that only careful and repeated study of numerous sections will reveal them. It is this factor largely which prompted Ewing, Lyons, Howard, Miller,¹⁹ Beath³ and others to feel that most, if not all, of the growths in so called benign cases reported were in fact cancer. We concur in this opinion. Such cases in which the growths were originally diagnosed as benign, and which were subsequently rechecked carefully and were found to be malignant, have been reported by Telger,²⁴ Streicher,²² Singer,²¹ David, Lyons, and others. All of the sections studied in our group were of malignant tissue.

Symptoms.—The symptoms are primarily those of linitis plastica of the stomach, which are similar to those of any slowly growing gastric cancer. Epigastric distress, which usually is worse after meals, sometimes relieved by taking soda and usually by vomiting, is the cardinal symptom. As the disease progresses and the size of the stomach diminishes, smaller and smaller amounts of food can be eaten. There is usually loss of weight and strength, and anorexia after the condition has advanced. When intestinal involvement becomes marked, the essential symptoms referable to the bowel are those of obstruction, and these may obscure the gastric pathologic condition. This occurred in two cases of our group. Duration of symptoms in this series ranged from seven weeks to 12 years.

General physical examination may or may not be helpful. Abdominal distention was evident in three of our cases and an epigastric mass was palpable in two instances. One of these was unusual in that instead of the stomach being contracted, it was hugely dilated because of pyloric obstruction. Achlorhydria was present in but one case, free hydrochloric acid of eight occurred in one case, and analysis of gastric content in the other two cases disclosed normal acidity. Anemia was only moderate, the readings of hemoglobin varying from 64 to 89 per cent. Dehydration and concentration of blood may have elevated these values.

Diagnosis.—It is difficult if not impossible to diagnose linitis plastica clinically with a reasonable degree of certainty (Streicher²²). The difficulty in recognizing the primary gastric lesion as a linitis plastica type of growth has been stressed frequently. Lyle cited only two correct diagnoses in 126 cases, and Lyons six in 38 cases. Kirklin¹⁴ expressed the opinion of most roentgenologists, namely, that one cannot hope to do more than diagnose the gastric lesions as carcinoma; to attempt to specify whether or not they are of linitis plastica type is impossible. Coe stated that the most outstanding roentgenographic feature is the rapid emptying time of the stomach. He described the usual outline of the stomach as that of a narrow inverted cone. Others have described it as being sausage shaped (Lyle, Baumgartner, Case, Deegan and Coe). Coe reported a case in which the gastric and colonic lesions were diagnosed preoperatively. We know of no other instance in which linitis plastica involving the colon has been diagnosed before operation. This applies to our six cases. In two of them, however, the diagnosis of low intestinal obstruction was obvious preoperatively.

Probably the most that can be said concerning the diagnosis of the intestinal lesion is: given a patient presenting a history and findings suggestive of linitis plastica of the stomach and who develops intestinal obstruction, consider the possible existence of an intestinal lesion of this type.

Prognosis.—Linitis plastica which has metastasized to the extent of involving the intestine is fatal. Rare cases, such as Case I of our series, are excepted and it must be kept in mind that sections for microscopic study were

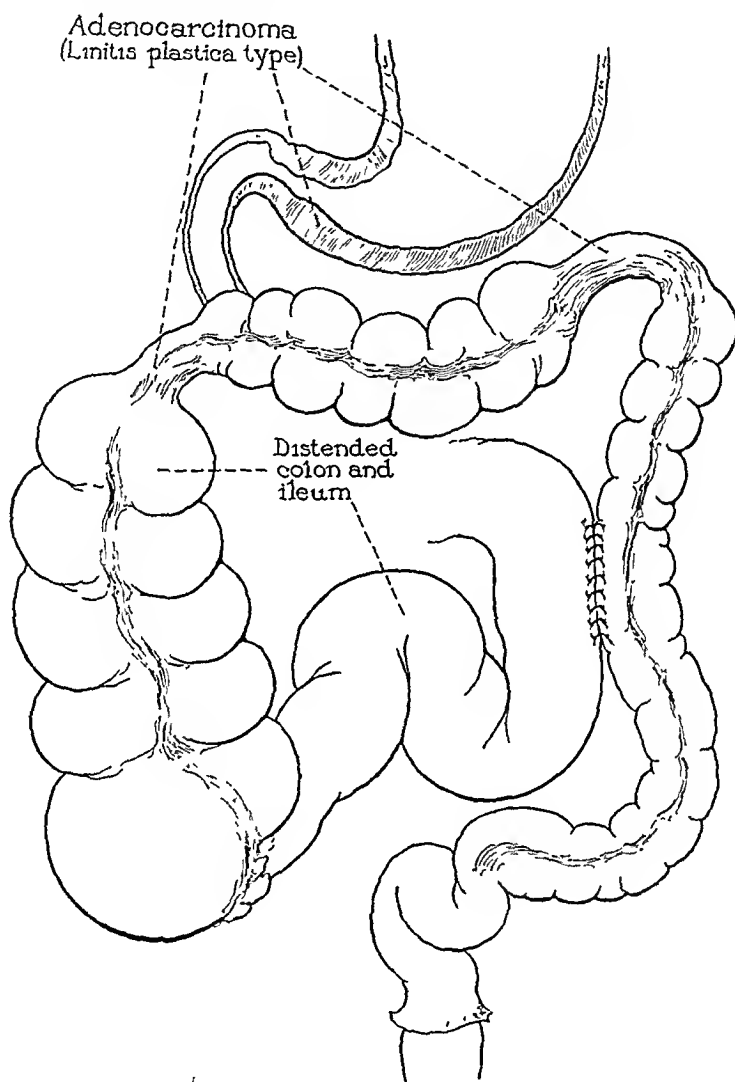


FIG. 5.—Ileocolostomy for palliative relief of obstruction, the degree of which is shown by dilatation of the ileum and ascending colon.

not available in this case. If the growth in this case was not benign, it must be a manifestation of spontaneous cure of cancer of which Ewing has spoken.

From the onset of symptoms (except in this one case) our group of patients lived from eight weeks (case with lesion of Grade 4) to two and one-half years.

Treatment.—Other than palliative treatment of linitis plastica of the intestine is futile since, as is evident from a review of our cases and of those

reported in the literature, multiple metastatic growths usually are present by the time the condition has progressed to a stage at which the pathologic change involves the intestine. Patients who are not immediately moribund, who are in fairly good general condition, and whose intestines are obstructed, probably deserve the palliative procedures of entero-anastomosis, ileosigmoidostomy, enterostomy, colostomy, or ileocolostomy (Fig. 5). Such types of operations were performed in our cases.

SUMMARY AND CONCLUSIONS

An effort has been made to review in some detail six cases of carcinoma of linitis plastica type involving the intestine. These cases, with the 37 such cases of which we have found reports in the literature, bring the total number to 43 reported to date.

Available data suggest that, although no doubt rare, the condition probably occurs with greater frequency than the number of cases reported would indicate. Although our group of cases as a whole is of interest chiefly because of the rarity of the lesion, two cases are of more interest because of the prominence of symptoms referable to the colon, namely, obstruction, and one case is of especial interest because the patient is still alive eleven years following exploration. The growth in this case may be benign, although the question of spontaneous cure of cancer arises. Diagnosis clinically is difficult. In all of our sections studied microscopically, malignancy was demonstrated. Without exception the primary lesion was found to be in the stomach.

In view of the usual existence of multiple metastatic growths, in addition to the presence of the gastric lesion when linitis plastica has reached the stage of intestinal involvement, other than palliative forms of treatment are futile.

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ACUTE REGIONAL ILEITIS

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CROHN, GINSBURG, AND OPPENHEIMER'S¹ description of regional ileitis (1932) has been followed by a number of confirmatory publications in the American and foreign literature.^{2, 3, 4, 5, 10, 11, 12, 13, 15, 16} This disease may be described as a chronic, hyperplastic, nonspecific inflammation of the lowermost section of the ileum, extending to and stopping at the ileocecal valve, and usually accompanied by an involvement of the adjacent mesenteric lymph nodes. Frequently more acute reactions supervene, which may lead to ulceration, even fistula formation, in the bowel wall and to suppuration in the lymph nodes. The pathologic changes appear, as a rule, severe and irreparable, so that the excision of the diseased intestines has been advised by some as the rational therapy.

With the increased recent attention given to this condition, observations have been accumulating which show that both the pathologic picture and the clinical course of these inflammatory processes may show considerable variations. Concomitantly, the surgical treatment has been varied, and the results obtained in several cases seem to prove that such a formidable procedure as a bowel resection is not always necessary.

It is this variability of the inflammatory process and the uncertainty concerning the indications for surgical procedures which prompt us to report three cases which have come under our observation. While most of the previous reports on regional ileitis emphasize the gradual onset and the chronicity of the symptoms, the clinical manifestations in our experience were those of an acute surgical abdomen urgently demanding exploration. The appearance of the inflamed bowel in these cases conveyed the impression that the inflammatory process was acute and probably transitory, not precluding a restitution of the diseased tissue. Accordingly, a minimal amount of surgical interference was attempted: in two cases only recourse was taken to a temporary deviation of the intestinal contents by an enterostomy. The result of this treatment was satisfactory. In one of these cases we could convince ourselves by a microscopic examination of the previously diseased ileum removed at a subsequent operation that a complete anatomic restoration had taken place. In the second case a similar spontaneous repair may be surmised in view of the patient's continuous freedom from symptoms. The third case is still too recent to permit an opinion concerning the final outcome.

CASE REPORTS

CASE I.—(No. 250506.) A boy, five and one-half years old, entered the Jewish Hospital complaining of abdominal cramps of six hours' duration. The pain came at intervals

and was, almost from the beginning, accompanied by vomiting. An hour after onset of the pain an enema had resulted in the evacuation of a formed stool.

In this clinical history the following details are noteworthy: Three years ago he supposedly had a similar though milder attack of abdominal pain. About the same time he had suffered from a persistent cervical adenitis with periods of recurrent fever, on account of which the adenoids were removed *and, after this had no effect, two enlarged lymph nodes were excised.*

The temperature on admission was 99° (rectal); pulse, 80; white blood cells, 19,000, with 92 per cent polymorphonuclears and 8 per cent lymphocytes. On physical examination an abdominal mass was seen and felt 2 cm. to the right of the umbilicus. Peristaltic waves could be observed traversing the abdomen and apparently stopping at the mass. On rectal examination no obstruction or tumor could be felt, but a definite amount of blood was expelled on withdrawal of the finger. Urine normal.

In view of these findings the diagnosis of intestinal intussusception, probably ileocecal, was made and an immediate laparotomy performed. The peritoneal fluid was not noticeably increased. The last 15 cm. of the ileum was much swollen, purplish red, and the serosa appeared finely granular and spotted with numerous petechiae. The mesentery of the involved section of the ileum was very edematous and contained many large lymph nodes, some attaining a diameter of 2.5 cm. No thrombosis was found in the mesenteric vessels. The cecum and appendix were apparently normal. The pathologic process stopped abruptly at the ileocecal junction. There was no invagination of the ileum into the cecum nor ecchymotic or abrasive marks suggesting a recently released intussusception. We considered the inflamed bowel segment viable and believed that a temporary deviation of intestinal contents would influence the inflammatory process favorably. A rubber tube was inserted into the ileum after the method of Senn, about 10 cm. above the ileocecal valve, still within the proximal limit of the involved intestine. The appendix was removed and one of the largest lymph nodes excised for microscopic study. The abdomen was closed and the enterostomy brought up close to the incision and fixed to the peritoneum.

The microscopic examination of the appendix showed no inflammatory changes. In the lymph node a marked inflammatory hyperplasia was found, but no indication of any specific infection.

The postoperative course was complicated. Fever persisting until the twenty-fifth postoperative day. On the second day after operation the patient passed a large amount of dark blood by rectum. On the fifth postoperative day the incision broke down, after which a considerable herniation with eversion of the enterostomy developed. Most of the intestinal content nevertheless found its way into the colon.

Three months after the operation the patient seemed in a satisfactory condition for the closure of the intestinal fistula. The appearance of the terminal ileum did not show any traces of the previous extensive inflammatory swelling. The lymph nodes in the ileocecal region, although still enlarged, were less than half the size of three months before. A short section of ileum containing the fistulous opening was excised and the continuity restored by an end-to-end anastomosis.

The microscopic examination of the resected piece of ileum revealed only blood extravasations and a minimal round cell infiltration in the subserous layer, which could easily be accounted for by the exposure of the bowel wall in the infected wound.

CASE II.—(No. 321945.) A male student, 27 years of age, entered the Jewish Hospital with the provisional diagnosis of acute appendicitis. After having partaken of food and drinks excessively the previous night, he was awakened by a moderately severe pain in the epigastrium which later localized in the lower part of the abdomen, slightly more on the left side. Prior to admission he had vomited four times. His bowels had moved after an enema. The patient stated that he had a similar attack of pain accompanied by nausea and vomiting only five days previously which kept him in bed for two days. His physician suspected at that time an acute appendicitis.

Examination of the abdomen revealed distention in the lower half. There was no visible peristalsis. Tenderness was quite diffuse, but more in the left lower quadrant. Distinct rebound pain was present on both sides. The rectal temperature was 102°; pulse, 110; white blood cells, 23,000; respiration, 22. The differential count showed 21 per cent stabs, 71 per cent polymorphonuclears, 3 per cent lymphocytes and 5 per cent monocytes.

Under the assumption that the patient was suffering from an acute appendicitis or diverticulitis, a laparotomy was immediately performed. The peritoneal fluid was found markedly increased and cloudy. The last 15 cm. of the terminal ileum was swollen, dark red and edematous. Its serosa was roughened and covered with shreds of fibrinous exudate. While the proximal limit of the inflammatory swelling was somewhat indistinct, the process stopped abruptly at the ileocecal junction. The mesentery adjacent to the involved part of the ileum was infiltrated, but did not contain any thrombosed vessels or blood extravasations, nor were its lymph nodes enlarged. The intestinal contents could be made to pass from the slightly dilated small intestines above the lesion through the involved segment into the cecum by gentle pressure and a milking manipulation. Nothing indicated a volvulus or strangulation. An enterostomy of the ileum just proximal to the lesion was made by inserting a catheter according to the Witzel technic. Three Penrose tubes were placed around the inflamed ileal loop because of the presence of a peritoneal exudate.

After the sixth postoperative day the temperature dropped from a peak of 104° and the patient recovered quickly. The intestinal fistula closed spontaneously a few days after removal of the tube.

The patient was reexamined two years after the operation. He complained of an occasional mild pain in the abdomen, not well localized, which was never severe enough to interfere with his daily routine or to make him consult a physician.

CASE III.*—The patient, a housewife 24 years of age, complained of mild abdominal cramps and occasional nausea for about five days. She had not interrupted her daily routine and attributed her discomfort to impending menstruation. On the day of her admission to the hospital the menstruation had ended, but her pain slightly increased. In the afternoon the temperature rose to 102°. Vaginal examination excluded an adnexal inflammation. The abdomen was soft, but tender in the right lower quadrant. In this area was also a rebound pain. The W. B. C. was 14,000; the differential count, 6 per cent stabs, 70 per cent polymorphonuclears and 24 per cent lymphocytes. Urine negative. The impression of all consultants was that these findings indicated an acute appendicitis, retroceally situated.

At operation the appendix was found thickened, edematous, but not acutely inflamed. The last six inches of the ileum were red, markedly swollen and stiffened. The mesentery was not thickened and did not contain palpable lymph nodes. The appendix was removed, the uterus and adnexa explored and found normal. The patency of the ileocecal valve was assured by careful palpation between two fingers. The abdomen was closed without drainage.

Microscopic examination of the appendix: The mucosa is everywhere intact. The lymphoid tissue is rather prominent. The subserosa is edematous. Bacteriologic culture from cross section of appendix: *Bacteria proteus valerii* in pure culture.

The postoperative course was short and uneventful. For about five days blood could be detected chemically in the feces. The patient left the hospital apparently cured on the ninth postoperative day. While still continuing on a diet free of roughage, patient has at present no complaints.

DISCUSSION.—Acute inflammatory processes in the terminal ileum were mentioned by Crohn¹ and co-authors in their original description. They con-

* We are obliged to Doctors Myer, Sale and Ehrenfest for permission to report this case.

sidered these conditions to be acute episodes or abortive stages of the hyperplastic and chronic regional ileitis. Clute,² Ladd,³ Harris, Bell and Brunn,⁴ Lewis⁵ and Jackman⁶ have made similar observations. The symptoms in these cases were those of an acute abdominal inflammation suggesting more or less appendicitis, while at operation an acute inflammatory engorgement of the distal segment of the ileum was found. The operative procedure varied between noninterference with the lesion and resection of the ileum, as for instance in Jackman's cases where the bowel wall was so severely compromised that it ruptured during the operation. In the few cases reported, the post-operative and final recovery has always been satisfactory.

The symptomatology of our cases was by no means uniform and hardly brings out any diagnostic feature which would facilitate the preoperative recognition of similar cases in the future. The findings in Case I were quite unusual and misleading. This patient, a five year old boy, presented all the symptoms of an acute intussusception: palpable tumor, visible peristalsis, intestinal hemorrhage and absence of temperature elevation. The considerable hemorrhage in this case is probably best explained as due to multiple erosions of the mucosa, which especially occur where submucous lymphatic plaques break down. At least the participation of the lymphatic apparatus in the inflammatory reactions was very conspicuous in the mesenteric lymph nodes, which attained a size usually seen only in acute mesenteric lymphadenitis. No palpable lymph nodes were present in the other two cases. Jackman, Lewis, and Ladd also fail to mention any lymph node hyperplasia in their acute cases, while all descriptions of chronic regional ileitis emphasize this finding.

The intensity of the inflammatory process and its sequelae varied considerably in our three cases. The inflammatory swelling was least pronounced in the last case and was commensurate with the comparatively mild and subacute symptoms. In the first case the engorgement of the ileum produced an intestinal obstruction, the swelling probably being intensified by exaggerated lymphatic reaction in the submucosa of the infantile gut. The severe infection of the bowel wall in the second case was accompanied by a localized peritonitis, but did not produce an obstruction.

Disease processes of the type here discussed are recent additions to the group of nonspecific inflammations of the intestinal wall. In this category may be included, at least until more is known about the pathogenesis of the different types, inflammatory processes of varying intensity, destructiveness and duration, but which have certain features in common: they are regional; *i.e.*, limited to a comparatively short segment of the intestinal tract. In contradistinction to the more common inflammations of the mucosa, they markedly involve the deeper layers of the intestinal wall. These inflammations evidently develop on the basis of a local infection and may run the course of an acute phlegmon or a chronic granuloma or any type of inflammation between these extremes. The bacteriologic study has only revealed bacteria of the common pyogenic or of the endogenous intestinal variety in the more

acutely inflamed tissues, while in the chronic granulating processes microorganisms may be practically absent. Trauma, various specific infections and malignant ulcerations of the mucosa and embolic infection, which occasionally lead secondarily to similar pathologic changes,⁷ can be excluded; and one has to assume that etiologic factors of an unknown nature must cause the invasion of the bowel segment by organisms which ordinarily remain innocuous in the intestinal tract. The primary regional inflammations are not common in the intestinal tract, although phlegmonous infections are frequent in the vermiform appendix and intestinal diverticula. Here stagnation of contents evidently favors infection.

The chronic nonspecific granulomatous inflammations of the colon have been recognized for many years.^{8, 9} It is now the opinion of most observers that chronic regional ileitis is essentially the same pathologic process, differing only in location. This contention is supported by observations of Colp,¹⁰ Brown, Bergen and Weber,¹¹ Röpke¹² and Phillips,¹³ who found terminal ileitis accompanied by a localized inflammatory process in the cecum or identical pathologic changes occurring in other segments of the ileum or even in the jejunum.

The acute, fulminant and phlegmonous infections, on the other hand, are usually found in the upper reaches of the intestinal tract, especially in stomach and duodenum. While phlegmons and mural abscesses have been also encountered in the colon, they take here, as Szabo¹⁴ has pointed out, usually a less acute course and quite frequently subside into a chronic secondary stage.

Thus it is suggested that the character of the inflammation is to some extent influenced by its location at the various levels of the intestinal tract. In a general way, regional ileitis bears out this rule. In accordance with the location of this segment midway between the proximal and distal halves of the intestines, the inflammatory processes frequently take a chronic course. But acute processes are evidently just as frequent, yet do not, as a rule, progress as readily to suppuration and necrosis as the phlegmons of the stomach, duodenum and jejunum.

Judging from our own experience and from the increasing number of reports in the literature, the terminal ileum seems to be a site of predilection for regional inflammations. This greater frequency of infections in this segment of the bowels may possibly be accounted for by its functional and anatomic peculiarities. Normally, the flow of the intestinal contents is retarded at the ileocecal valve which necessarily leads to some degree of stagnation in the terminal ileum. Furthermore, the lymphatic tissue in the mucosa and submucosa is here more abundant than in other segments of the bowel, a factor which favors the absorption of microorganisms.

CONCLUSIONS

(1) Three cases of acute regional and intramural inflammation of the terminal ileum with symptoms of an acute intra-abdominal condition are described.

(2) The patients recovered after laparotomy without resection of the diseased segment of bowel.

(3) The relation of this disease to other nonspecific inflammations of the intestinal wall are briefly discussed.

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UNUSUAL INFLAMMATORY LESIONS OF THE ILEOCECAL REGION

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THE purpose of this paper is to call attention, by the use of three clinical reports, to the interrelationship of inflammatory lesions of the terminal ileum, appendix, cecum, and ileocecal lymph nodes. The first case is one of diffuse inflammation of the terminal ileum, appendix, and cecum with secondary involvement of the ileocolic nodes in the mesentery. In the second case, the tip of an old, inflamed appendix, obviously the primary focus of infection, was adherent to a mass of enlarged mesenteric nodes. The third case is one of acute primary typhlitis with localized, ulcerative, inflammatory changes in the wall of the cecum, and no involvement of the appendix.

CASE REPORTS

CASE I.—(Hospital No. 3326.) A white boy, aged 12 years, was admitted to the hospital because of pain in the right lower abdominal quadrant. The past and family histories were irrelevant.

The present illness began five days previously with cramp-like, generalized, abdominal pain associated with nausea but no vomiting. Examination two days later showed some congestion of the nasal mucous membrane and the rhinopharynx, slight tenderness to deep pressure throughout the lower abdomen, but no rigidity. The temperature was 99.4° F. by mouth, pulse 60. The following day the patient reported the passage of several tarry stools; the pain became localized in the right lower quadrant and persisted, with nausea and fever, until admission to the hospital.

The physical examination revealed a tall, thin, somewhat undernourished boy, with generalized cervical, axillary, and inguinal adenopathy of moderate degree. A hard, tender, nodular mass, with overlying muscle spasm, was palpable in the right lower abdominal quadrant, but could not be felt by rectal examination.

Clinical Pathologic Data.—Temperature 101.2° F., pulse 94, respirations 24. The leukocytic count was 11,920 with 69 per cent polymorphonuclear neutrophils. The urine was normal. The Wassermann was negative. The following day the leukocytic count was 13,300 with 76 per cent neutrophils.

Roentgenogram of the abdomen showed no evidence of calcified nodes nor anything else unusual. There was considerable gas in the colon.

Preoperative Impression.—Appendiceal abscess.

Operation was performed under ether anesthesia 12 hours after admission. McBurney incision. The amount of free fluid in the peritoneal cavity was increased and the omentum was adherent to a hard, indurated, nodular mass of inflamed lymph nodes just medial to the proximal portion of the ascending colon, which extended upward in a rather elongated form toward the midline (Fig. 1). The cecum, appendix, and terminal ileum were diffusely thickened, inflamed, and injected. There was no obvious obstruction of the intestinal lumen and resection was not considered advisable. The appendix and one enlarged node in the mesentery, just proximal to the ileocecal valve, were removed and the abdomen was closed without drainage.

Postoperative Course.—Characterized by a persistent elevation in rectal temperature which averaged approximately 100° F. each evening. Smear of the peritoneal fluid showed no microorganisms and no pus; the culture was sterile. The tuberculin test was negative on three occasions. The leukocytic count returned to normal. Examinations of the stools for ova, parasites, and occult blood were negative. Roentgenogram of the chest showed nothing unusual. Barium enema flowed freely around to the cecum and disclosed no abnormality in the outline or behavior of the colon. Patient discharged on the eighteenth postoperative day. The abdominal mass was not palpable.

Pathologic Diagnoses.—Subacute appendicitis and necrosis of lymph node. One section through the tip of the appendix showed a considerable amount of acute inflammatory exudate in the lumen; polymorphonuclear cells were scattered at rare intervals through the stroma and one of the lymphoid follicles was filled with these cells. There were also many plasma cells in the mucosa; no inflammatory reaction was seen in any

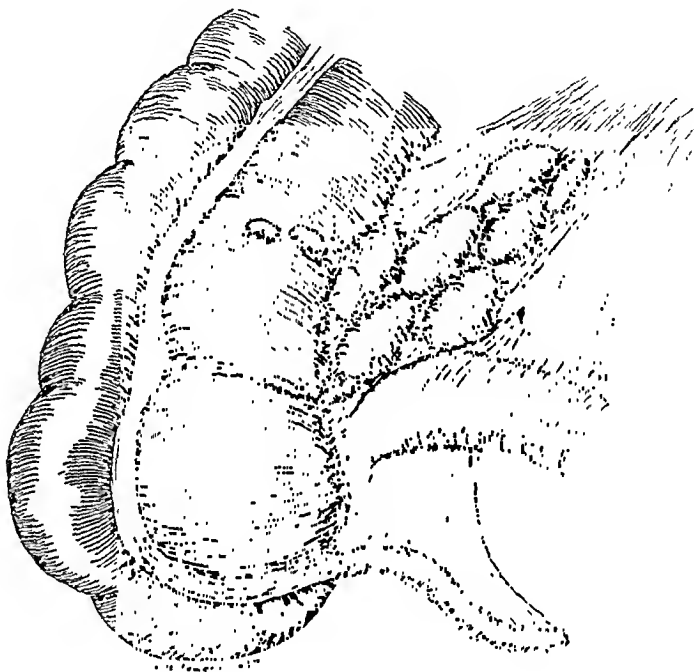


FIG. 1.—Diagrammatic sketch of the operative findings in Case I.

of the other coats. The section of lymph node was so necrotic that no cellular structure could be made out.

Comment.—The exact sequence of events in this case is by no means obvious. The fact that the patient has been completely cured by removal of the appendix (in view of the negative tuberculin and the absence of any microscopic evidence of tuberculosis in the lymph nodes), suggests that the process was a diffuse inflammatory one, primary in the appendix and secondarily involving the terminal ileum, cecum, and ileocecal lymph nodes. The microscopic examination of the appendix is not incompatible with this opinion. To be sure, the regional lymph nodes are not usually involved in the ordinary case of acute appendicitis, but such is also true with the common type of sore throat or infected finger. Yet one is not surprised occasionally to see diffuse edema of the hand with extensive involvement of the axillary nodes from an apparently trivial infection of the finger, and the author is inclined to believe a

similar type of reaction may rarely occur about the appendix, the ileocecal region, and the lymphatic structures which drain this portion of the alimentary canal.

CASE II.—(Hospital No. 8011.) A white male, 17 years of age, was admitted to the hospital because of abdominal pain and a tender swelling in the right side below the umbilicus.

The family history was irrelevant. The past history revealed an attack three months previously, similar to the present one, which lasted for two days and was followed by complete recovery. His weight was normal and his general health was good.

The present illness began six days prior to admission with a dull ache in the lower abdomen, anorexia, but no nausea or vomiting. Two days later castor oil was administered; the pain increased in severity and became localized in the right lower quadrant where the patient himself discovered a tender mass. Frequency of urination and nocturia ensued.

The physical examination was normal except for the abdomen, which was somewhat doughy and resistant throughout, with definite spasm in the right lower quadrant where an elliptical, tender, indurated, nodular mass could be felt in the right iliac fossa. The tumor extended from the umbilicus above to the pubis below and from the border of the right rectus muscle laterally to just beyond the midline; it was slightly movable. There were no palpable nodes in the axillae or groins.

Clinical Pathologic Data.—On admission the rectal temperature was 101.2° F., pulse 98. Leukocytic count 11,600 with 75 per cent polymorphonuclear neutrophils. The following day the temperature had risen to 102.6° F., pulse 80. Hemoglobin 76 per cent, red cells 3,788,000, leukocytic count 9,400 with 81 per cent neutrophils. The Wassermann reaction was negative in both antigens. Urine normal.

Röntgenogram of the abdomen showed nothing remarkable. Fluoroscopic examination of the colon, following the injection of barium, disclosed no evidence of pathology.

Preoperative Impression.—Appendiceal abscess lying directly beneath the anterior abdominal parietes.

Operation was performed under ether anesthesia 36 hours after admission. The abdomen was opened through a low right rectus incision, placed directly over the mass, to which the omentum was adherent by a few fresh inflammatory adhesions. The tumor consisted of numerous indurated, rounded, and egg-shaped lymph nodes varying from 1 to 3 cm. in length and 1 to 2 cm. in diameter which lay along the medial wall of the ascending colon and extended posteriorly into the retroperitoneal space. The nodes were inflamed, edematous, and matted together. The cecum and ascending colon were not constricted. The walls were thickened where they came in contact with the lymph nodes, and the anterior surface was inflamed and speckled in appearance although no actual tubercles were seen. A search was made for the appendix which was finally found as a thin, cord-like structure, extending upward behind the cecum and densely adherent to its posterior wall. It was removed in retrograde fashion from the base toward the tip which was firmly embedded in the largest of the lymph nodes (Fig. 2).

One node was sent to the laboratory for immediate microscopic examination which was reported to show no evidence of malignancy or tuberculosis. The abdomen was closed without drainage.

Postoperative Course.—Uneventful. Discharged 13 days postoperative. Examination at that time showed a marked decrease in the size and tenderness of the abdominal mass. The patient was free from pain or discomfort, his appetite was good and his bowels were regular.

Pathologic Report.—Acute adenitis of cecal lymph node; the node was heavily infiltrated with polymorphonuclear leukocytes. The appendix was 6 cm. in length

and varied between 2 and 5 mm. in diameter. A probe could not be inserted into the lumen and the histology was so distorted as to be unrecognizable.

The patient was seen one year later and stated that he had had some residual soreness in the right lower abdominal quadrant for one month following his discharge from the hospital but none since. Examination showed a well healed wound just lateral to which could be palpated a small firm, nodular, nontender tumor. The leukocytic and differential counts were normal. A year later the abdominal mass had disappeared.

Comment.—This case is unquestionably one of acute mesenteric adenitis secondary to appendicitis. On the basis of the operative findings and the microscopic appearance of the tissue, it seems probable that the nodes were involved primarily by direct extension of an inflammatory process in the appendix which completely destroyed the usual histology of this organ during

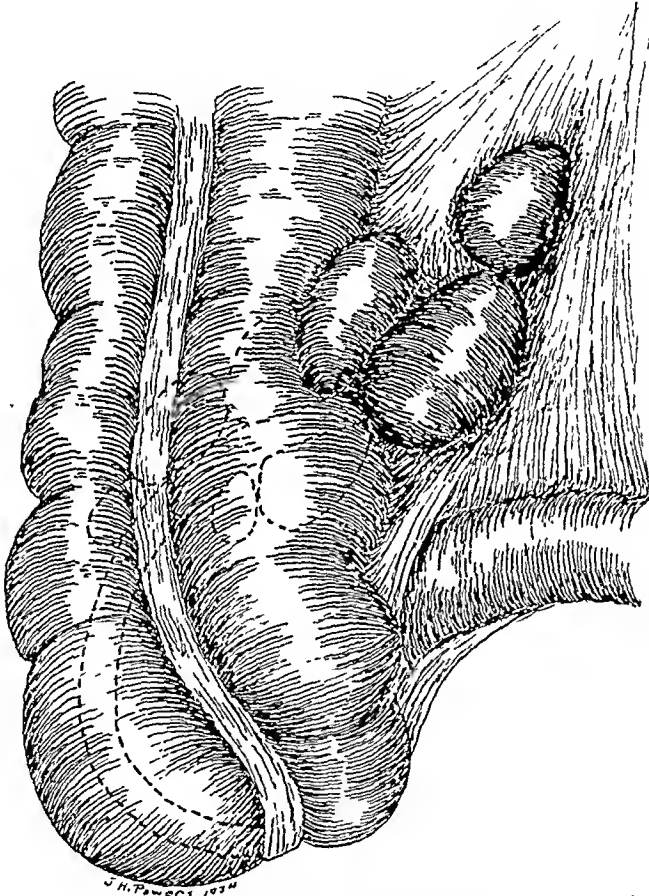


FIG. 2.—Operative sketch of the relationship of the appendix to the ileocecal lymph nodes in Case II.

the initial illness, and that the second attack of pain was due to peritoneal irritation by the mass of inflamed lymph nodes rather than to the recurrence of appendiceal colic.

CASE III.—(Hospital No. 6011). A previously healthy man, 33 years of age, a painter by occupation, entered the hospital because of abdominal pain. The past and familial histories were irrelevant.

The present illness began four days previously with severe cramplike abdominal pain, located chiefly in the left upper quadrant but radiating across to the right side. There was no nausea or vomiting. The following day the pain was largely relieved by the local application of ice to the abdominal wall; after removal of the ice packs the

cramps recurred at half-hourly intervals until admission to the hospital two days later. The patient had little desire for food; his bowels moved satisfactorily without catharsis and the stools were normal in character.

The physical examination revealed no lead line. The heart and lungs were normal. The abdomen was tender to pressure throughout the right side, particularly in the lower quadrant where overlying muscle spasm and cutaneous hyperesthesia were present. Rectal examination disclosed nothing unusual.

Clinical Pathologic Data.—Temperature 100.2° F., pulse 94 and respirations 20. The leukocytic count was 9,700 with 71 per cent polymorphonuclear neutrophils. The urine was normal and the Wassermann reaction was negative.

Preoperative Impression.—Acute appendicitis.

Operation was performed under general anesthesia. The abdomen was opened

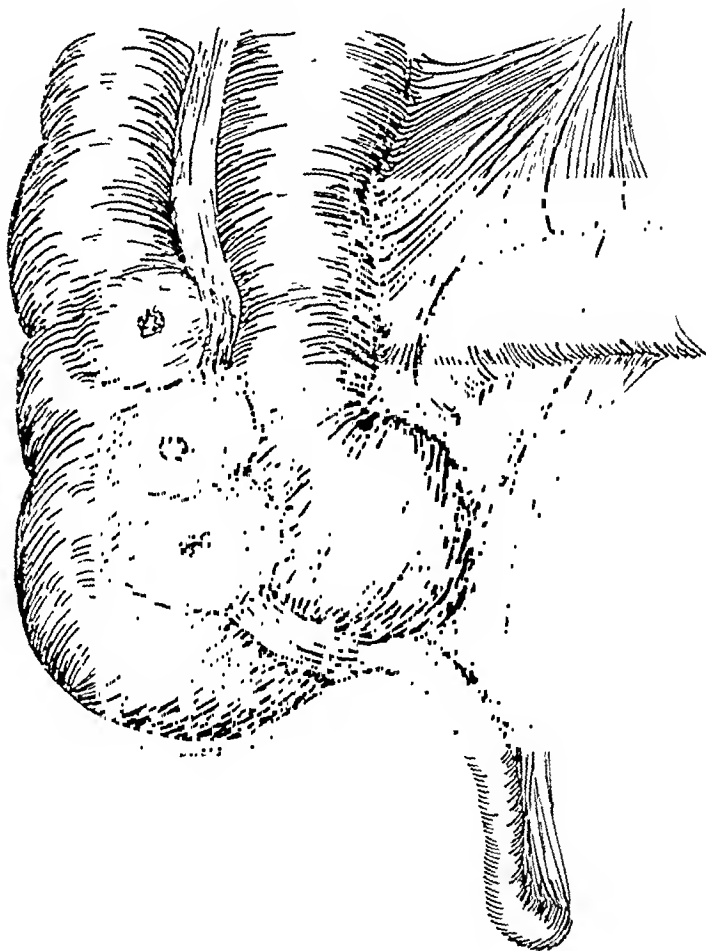


FIG. 3.—(Case III.) Primary ulceration of the cecum.

through a right rectus incision. Fresh inflammatory adhesions were found about the cecum; the appendix was congested but no fibrin was present. Three cm. above the base of the appendix the serosa of the cecum was acutely inflamed and granular in appearance. Palpation of this area disclosed three definite nodules in the cecal wall, about 2 cm. in thickness and 1 cm. apart (Fig. 3). No definite craters could be made out. The appendix was removed, the inflamed portion of the cecum resected and the wound closed in layers with silk.

Postoperative Course.—Characterized by an abrupt elevation of temperature to 102.2° F. which gradually subsided to normal on the sixth day. The wound healed satisfactorily and the patient was discharged at the end of two weeks. There has been no subsequent complaint.

Pathologic Diagnosis.—Ulcers of cecum and normal appendix. The ulcers in the excised cecal wall were 2.5 by 1 cm. in diameter and oval in shape, with their long axes transverse to the lumen of the gut. The surrounding intestinal wall was thickened and injected and the serosa was inflamed. The surface of the ulcers was covered with necrotic exudate beneath which could be seen microscopically a dense layer of polymorphonuclear leukocytes. Lying on the muscularis was a still deeper layer of inflammatory cells, fibroblasts and fibrin. Sections stained with the Gram stain showed numerous gram-positive bacilli, particularly abundant in the superficial necrotic membrane covering the ulcers. Sections of the appendix revealed nothing abnormal.

Comment.—This case is doubtless one of primary nonspecific typhlitis. The appendix was not involved in the inflammatory process which was strictly confined to the cecum. Several similar cases have been reported in the past, either as "stercoral ulcers," simple inflammatory lesions, or ligneous infection of the cecum.

DISCUSSION.—Great diversity of opinion exists regarding the etiology of these unusual inflammatory lesions of the terminal ileum, cecum, and appendix, their relationship to one another, and to acute mesenteric adenitis along the paths of lymphatic drainage. A large series of cases may be found in the literature under the general term of benign, nonspecific granulomata. This group includes both acute and chronic inflammations of the small and large intestine, the cause of which remains unknown.

Regional Ileitis.—In 1932, Crohn, Ginzburg, and Oppenheimer¹ attempted to segregate from this heterogeneous collection a group of inflammatory lesions of the terminal ileum to which the term "regional ileitis" was applied. They described the condition as a definite clinical and pathologic entity which did not extend beyond the ileocecal valve and bore no relation to the appendix except such involvement as might occur to the outer coats of that organ by the presence of adjacent inflammatory disease.

In 1933, Harris, Bell, and Brunn² published three cases, in one of which the jejunum was mainly involved; the adjacent mesentery in each instance was thickened and edematous and the lymph nodes were enlarged. Because of the involvement of the small intestine above the terminal ileum the name "chronic cicatrizing enteritis" was suggested as a more appropriate term. In a later report, Crohn³ records a case in which the whole ileum and lower jejunum were involved and mentions another, "probably tuberculous," of diffuse involvement of the lower jejunum and upper ileum. This same authority, in his discussion of Kantor's paper,⁴ stated that the disease was much more common than hitherto suspected and mentioned one case in which the inflammatory area transcended the ileocecal valve to involve the cecum. These facts tend to support the opinion of Homans and Hass⁵ who presented two cases with a similar clinical picture. They refused to admit that the malady was a specific pathologic entity and considered a possible but unproved relationship of the disease to appendicitis. The appendix in one of their cases was ulcerated and in the other was partly destroyed by fibrosis. In both instances the mesenteric lymph nodes at the ileocolic angle were numerous,

enlarged, and inflamed. Clute⁶ has published two such cases, in each of which the mesentery was boggy, edematous, and filled with hyperplastic lymph nodes which he suggested might be the primary site of the infection. Rockey⁷ reported four cases of thickening of the terminal ileum with mesenteric adenitis in children, in none of which the appendix was involved either grossly or microscopically. All the patients were cured by simple appendectomy, a fact which seems strange if this organ were not the primary focus of infection.

From this brief résumé of the literature it is apparent that the etiology of nonspecific inflammation of the terminal ileum is entirely obscure, that the pathologic process may involve other portions of the small intestine and at times may even transcend the ileocecal valve to include the proximal portion of the large bowel.

Inflammatory Lesions of the Cecum.—In reviewing cases of “typhlitis” and nonspecific inflammatory lesions of the cecum one is impressed by the overwhelming number in which the appendix is implicated either by previous or coexistent inflammation. In the latter type, the organ is involved in the general process and is assumed, with some degree of reason, to be primarily responsible for the disease. In the former a history is obtained of previous appendectomy or of recurrent attacks of abdominal pain which might be clinically ascribed to the appendix. And often when the organ appears grossly normal at operation, microscopic examination reveals evidence of chronic appendicitis. Frequently the ileocolic lymph nodes are described as more numerous than normal, enlarged, juicy, hyperplastic or inflamed.

On the other hand, simple inflammatory tumors of the transverse colon and sigmoid have been reported, so one may reasonably assume that a similar type of lesion occurs in the cecum which has no primary relationship to the appendix. Bernard and Melone,⁸ in summarizing an article on acute typhlitis, state that unquestionably such a disease does exist but that the limits of primary typhlitis ought to be more carefully defined for much that has been described as such is, in reality, secondary to appendicitis.

Wilkie,⁹ in his studies on the pathology of the cecocolic sphincteric tract of the colon, suggests a possible explanation for the susceptibility of this part of the intestinal tract to morbid processes. He calls attention to the work of Keith in demonstrating three distinct segments in the proximal part of the colon of air breathing vertebrates, namely, the cecum, the cecal colon, and the cecocolic sphincteric tract. This tract, immediately distal to the caput coli, is frequently in a state of tonic contraction in herbivorous animals and corresponds anatomically to a contracted zone in the human colon which is often described at the sphincter of Busi.¹⁰ Furthermore, this sphincteric region coincides with that in which pathologic processes are particularly prone to occur. Roith and others have established that anastalsis takes place in the proximal part of the human colon, and radiologic studies, after the ingestion of an opaque meal, have demonstrated repeatedly that the forward passage of the intestinal contents is delayed for several hours in the cecum, a delay

which is due not so much to a passive obstruction as to an active repulsion of these contents until cecal digestion and absorption have been completed.

Wilkie concludes: "All writers are agreed that the human cecum approaches more nearly to the herbivorous than to the carnivorous type. As Keith points out, the diet of highly civilized races is so different from the crude and primitive food supply for which the human cecum was originally evolved that it is not surprising to find that this portion of the alimentary canal, working as it does under unnatural conditions, should be especially liable to morbid changes."

Furthermore, pathologic lesions are prone to occur in other parts of the gastro-intestinal tract just at or proximal to points of constriction. The predilection of peptic ulcers for the region of the pylorus is well known. If temporary stasis at this point contributes toward ulceration of the stomach, it is reasonable to expect that ulcers might also occur in the cecum (as in fact they actually do) just proximal to the cecocolic sphincteric tract. To pursue the theory further, the decrease in the lumen of the terminal ileum and the constriction at the ileocecal valve may be at least partially responsible for the development of regional ileitis. Further support for this hypothesis is suggested by the fact that such pathologic processes frequently undergo spontaneous resolution if an anastomosis be performed around the obstructed and inflamed portions of intestine.

Ileocecal Lymphadenitis.—The etiology of inflammatory lesions of the lymph nodes situated in the ileocecal angle of the mesentery is still a subject of controversy. Many authors believe that the majority of these cases is tuberculous in origin, even when no tubercles or bacteria are demonstrable by microscopic examination. On this basis, simple lymphoid hyperplasia is explained as due to "absorption of toxins from ulcerated tuberculous lesions in the musoca" or "reactions provoked by invasion of the tubercle bacillus,"^{11, 12} possibly from the irritation of toxins." Unfortunately, sound surgical judgment at the operating table has not permitted exploration of the lumen of that portion of the intestine which was suspected of being the primary tuberculous focus. Unquestionably, many cases of mesenteric lymphadenitis are tuberculous in origin; on the other hand, the absence of histologic evidence of this disease in the excised nodes, negative intradermal tests, the immediate disappearance of symptoms, and rapid healing in many cases suggest a simple pyogenic origin. Wilensky^{13, 14} has taken a firm stand on this basis and contributed much toward clarifying the etiologic and pathologic confusion. According to his classification, mesenteric adenitis may be divided into simple, suppurative, tuberculous, and calcified. The first includes a uniform discrete enlargement of the mesenteric nodes in which the pathologic picture is one of simple hyperplasia. The second differs only in degree; more extensive pathologic changes and suppuration occur. The third is frankly tuberculous and the fourth is a terminal affair, the end result when healing occurs in either the second or third groups. Abundant evidence to support the existence of simple hyperplastic or pyogenic adenitis may be found in the reported cases

of regional ileitis where the involvement of the mesenteric nodes is apparently secondary to an inflammatory process in the ileum. That such an adenitis is not usually found in the ordinary case of acute appendicitis may be due either to the fact that the patient is operated on so early that sufficient time has not lapsed for the ileocecal nodes to become involved, or, in the event of a late operation, to the fact that the efforts of the surgeon to avoid contamination of clean peritoneal surfaces do not permit exposure and exploration of the mesentery.

From the standpoint of anatomic knowledge, one might expect frequent involvement of the ileocolic nodes in the presence of appendiceal inflammation. Kelly¹⁵ states: The lymphatics of the appendix may be divided into three more or less distinct systems which are identified with the coats of the appendix,

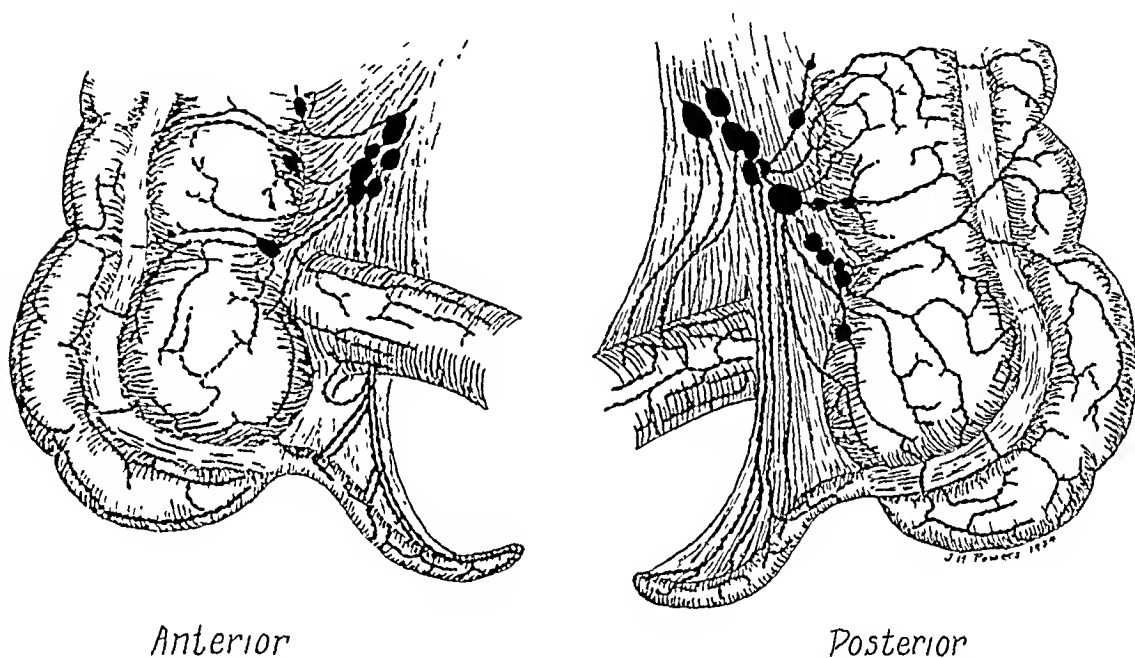


FIG. 4.—Diagrammatic sketch illustrating the lymphatic drainage of the terminal ileum, appendix, and cecum (after Kelly).

the superficial, lying in the serosa; the middle, situated between the submucosa and layer of circular muscle fibers; and the deep, consisting of a very complex anastomosing network, the central layer of which lies between the mucosa and the muscularis mucosae; delicate, fingerlike terminal branches, running parallel to and between the glands of Lieberkühn, drain the mucous membrane. The collecting channels, running in pairs, form one to three separate bundles passing along the free border of the meso-appendix. If there are more than one, the others run at fairly regular intervals between the main bundle and the cecum. All converge toward the appendiceal nodes which are generally situated at the lower median angle of the ileocolic chain. Glandular substations, or isolated glands in the meso-appendix or in the appendicocolic angle, are rare (Fig. 4). In view of (a) the similarity between the lymphatic apparatus of the appendix and terminal ileum; (b) the frequency of mesenteric adenitis as an accompaniment of regional ileitis; and (c) the lack of interest in the ileocolic nodes

in the presence of obvious appendicitis, it is quite possible that these nodes are involved more frequently than is generally suspected.

In his first paper, Wilensky¹³ felt that the source of infection in cases of ileocecal lymphadenitis was most commonly in the appendix. In the second paper,¹⁴ six years later, he believed that the Peyer's patches in the intestinal wall formed the point of entry similar to the rôle which the tonsils play in cervical adenitis—and that no clinical relationship existed between appendicular infection and mesenteric adenitis. The prompt subsidence of symptoms following appendectomy in his early cases, in the cases reported by Rockey,⁷ and in the first two cases recorded above, and the anatomic relationship of the lymphatic channels of the appendix to the ileocecal lymph nodes suggest that the appendix does play some part in the etiology of this interesting form of glandular inflammation.

SUMMARY

(1) Three cases of unusual inflammatory lesions of the ileocecal region have been described in detail. The first was that of a patient with diffuse inflammation of the terminal ileum, appendix, and cecum, and secondary involvement of the ileocolic nodes in the mesentery; in the second case, the tip of an inflamed appendix was adherent to a mass of enlarged mesenteric nodes; the third case was one of primary typhlitis with localized, ulcerative, inflammatory changes in the wall of the cecum.

(2) Regional ileitis, acute nonspecific inflammation of the cecum, and mesenteric lymphadenitis in the ileocolic angle have been discussed.

(3) Certain etiologic factors and the possible interrelationship of these lesions to one another have been suggested.

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PRIMARY CARCINOMA OF THE FALLOPIAN TUBES

REPORT OF TWO CASES

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IN A thorough search of the American and foreign literature from 1888 to 1935 on primary carcinoma of the fallopian tubes, 323 cases were found to have been reported. This is a far greater number than is mentioned in the American literature. Of Liang's¹ 214 recorded cases in 1926, 107 were reported in the German literature. Only brief mention is made of the subject in text-books of pathology and surgery. Even this number of cases is too small to consider the subject of primary carcinoma of the fallopian tubes as complete; hence the reason for reporting two additional cases. Many more will have to be reported before we can gather enough facts about this subject to class it as a definite entity among gynecologic diseases.

Today so little is known about the subject by most surgeons that the possibility of the diagnosis is seldom considered—none did in the past with the exception of Falk,² and this only after removing a piece of tissue through an abdominal puncture.

Orthmann³ was the first to describe primary carcinoma of the fallopian tubes in 1888. In 1895, Sänger and Barth⁴ gave a detailed description and classification of primary carcinoma of the fallopian tubes, declaring that it always develops at the seat of a chronic and most frequently suppurative salpingitis long quiescent. Peham,⁵ in 1903, collected 63 cases. Three years later Orthmann⁶ collected 84 cases, and in 1910 Doran⁷ tabulated in detail 100 cases. A year later Andruze-Acher⁸ added 15 and in 1914 Vest⁹ 32. In 1925, Liang collected 214 cases. Wechsler,¹⁰ in 1926, tabulated 192 cases from the literature and reported four new cases. Wharton and Krock,¹¹ in 1929, found in the literature 230 cases and reported 14 of their own from Johns Hopkins and neighboring hospitals. When Johnson and Miller¹² reported their case in 1931, they found in the literature 250 cases. Walther Haupt,¹³ in 1933, collected 321 cases and reported one of his own. Kahn and Norris¹⁴ reported a case in 1934, making a total of 323 cases of primary carcinoma of the fallopian tubes from 1888 to 1934.

Among 2,020 gynecologic specimens at the University of Pennsylvania, only one case of primary carcinoma of the fallopian tubes was found (Norris¹⁵). Only five cases were found in 35,000 patients with gynecologic conditions at the Johns Hopkins Hospital (Wharton and Krock); at the Lenox Hill Hospital four times in 5,870 specimens (Wechsler); at Bellevue Hospital three times in 30,000 patients with gynecologic conditions (Barrows¹⁶). According to Johnson and Miller¹² it occurs in about 0.45 per cent of all genital tumors.

Carcinoma of the fallopian tubes occurs most frequently about the menopause, usually between 40 and 50, but cases have been observed as early as 18 (Johnson and Miller), and as late as 73 (Mentul, quoted by Wechsler). Pelvic inflammation and sterility, in turn due to pelvic inflammation, are predisposing factors (Sänger and Barth, Norris, Ewing,¹⁷ Doran). The importance of pelvic inflammation is questioned by Vest, Wechsler and Liang. Some cases are on record that had no history of inflammation. One case is reported that occurred in a virgin (Spencer¹⁸). The second case is being reported in this paper. The majority of cases begin as multiple papillary outgrowths of an inflamed mucous membrane which become malignant (Ewing, Doran). Over 75 per cent were reported as papillary carcinoma. The classification of Sänger and Barth seems to be the most logical and simple. They occur either as papillary carcinoma or papillary alveolar carcinoma. The latter is sometimes reported as adenocarcinoma.

The symptoms of pain, serosanguineous discharge and palpable tumor are not typical of this disease alone, especially when one takes into consideration that about 9 per cent of cases are associated with uterine fibroids, ten per cent with cystic tumors of the ovaries, and chronic adnexal diseases, for which so many of these cases are being operated upon.

The pain differs from that of carcinoma of the uterus in appearing early in the disease. It is a constant, lancinating, colicky pain, which in some cases stops abruptly following a profuse vaginal discharge. This occurs when a distended tube empties itself through the uterine ostium, as reported by Roberts¹⁹ and Edelberg.²⁰ Occasionally, some malignant tissue is extruded with the discharge. When the abdominal ostium is open, the contents of the tube are emptied into the abdominal cavity, thus disseminating the malignancy to the peritoneum, followed later by ascites. Ascites, however, occurs only in about 10 per cent of the cases, as in the majority the abdominal ostium is closed. In lymphatic metastasis ascites may follow in the same manner through peritoneal and mesenteric involvement.

In most obscure surgical cases, diagnosis is usually made in the operating room. Even this is not always the case in primary carcinoma of the fallopian tubes, unless the tube is sectioned and examined before the abdomen is closed. Wharton and Krock called attention to this fact. The fear of criticism by the pathologist for "spoiling a specimen" by sectioning often results in secondary operations after the pathologic report is received.

Diagnosis of primary carcinoma of the fallopian tubes may be made when the patient complains of a profuse serosanguineous discharge with various menstrual irregularities, abdominal pain with a palpable adnexal tumor, and a negative report of the uterine curettings. Indiscriminate use of radium to arrest vaginal bleeding without a pathologic diagnosis should be condemned, as some cases in the past have proved to be primary carcinoma of the fallopian tubes.

Radical surgery with the removal of both tubes and ovaries and complete hysterectomy with wide excision of the broad ligaments is the treatment of

choice. This is followed later by roentgen ray therapy. The operative mortality is about 6 per cent.

The prognosis of primary carcinoma of the fallopian tubes is very poor. Metastasis usually takes place by the lymphatic route, involving the retroperitoneal nodes, resulting in large tumor masses filling the abdomen, or by direct implantation from a tubal ostium involving the omentum and mesentery, associated with ascites in about 10 per cent of cases. Metastasis is usually limited to the lower abdomen. The liver was involved in only three cases. It is the most malignant type of all gynecologic tumors, perhaps including carcinoma of the ovaries. As stated by Wharton and Krock, "If we were to base the prognosis entirely on the results of the past, it would be necessary to conclude that the outlook is almost hopeless." Only 4.5 per cent of the cases reported have obtained a three year cure and but seven cases survived longer than three years. Haupt's case survived nearly 20 years; Fonyo's²¹ 13 years; Zweifel's²² eight years; Veit's²³ seven years; Jahkola's²⁴ six and seven years, and Benthin's²⁵ five years.

CASE REPORTS

CASE I.—E. K., a white adult female, aged 52, not married, was admitted to the Brooklyn Cancer Institute January 8, 1935. Chief complaint: lower abdominal pain and vaginal bleeding. The bleeding was of two weeks' duration, scanty and serosanguineous in character. The pain was intermittent. The patient had had her menopause two years previously. Menses began at 18 with only occasional irregularities, lasting five days. She had had only a slight amount of leukorrhea between menstrual periods, and never any pelvic pain before. She was a virgin. She had had the usual childhood diseases and had become deaf following measles. Her family history was irrelevant.

Physical examination revealed a white adult female, well nourished, appearing much younger than her age, weighing 118 pounds, about five feet three inches in height, temperature 99°, pulse 82, respirations 20, blood pressure 120/80. The abdomen was soft, ovoid and not tender. There were no visible or palpable masses present. Pelvic examination revealed a virginal introitus, admitting only one finger. A mass the size of a small orange was felt in the left fornix. The body of the uterus could not be palpated. Heart and lungs normal. Urine normal and blood Wassermann negative. Hemoglobin 60 per cent, red blood cells 3,700,000, with 4,950 white cells, 81 per cent polymorphonuclears, 19 per cent lymphocytes.

January 10 an exploratory laparotomy was done by Dr. John J. Gainey. The left tube and ovary were found to be buried by adhesions in the left fornix and culdesac, forming one mass. On freeing this a tumor the size of a small orange was found at the fimbriated end of the tube. A left salpingectomy and appendectomy were done. The patient made an uneventful recovery.

Pathologic report by Dr. Polayes: *Macroscopic Examination*.—Specimen an ovid mass 8½ cm. in length and 4 cm. in greatest diameter. The tissue consists of the fallopian tube, the distal end of which is markedly dilated and filled with gray granular friable tissue. There is a small cystic area about 1 cm. in diameter on the surface of the mass.

Microscopic Examination.—Tissue consists of tubal wall, the lining of which shows a transition into malignant epithelial cells which grow in papillary formation and destroy the architecture of the ampulla of the tube beyond recognition. Section through the tumor mass shows a solid growth of epithelial cells which are entirely anaplastic (Fig. 1).
Diagnosis: Papillary adenocarcinoma of ampulla.

A week later the patient was given a transfusion of 500 cc. of blood and a

panhysterectomy was done, removing the left ovary, right tube and ovary and uterus.

Pathologic report by Dr. Polayes: Macroscopic Examination.—Specimen consists of two portions, one composed of uterus and its appendages, and the cervix uteri. The uterus measures $4\frac{1}{2}$ by $4\frac{1}{2}$ by 2 cm. The right tube measures $9\frac{1}{2}$ cm. in length, 6 Mm. in its widest diameter, and the midportion of which presents a hemorrhagic infiltration involving the entire wall at this point for a distance of 3 cm. A small peritubal cyst is present. The left tube is missing and suture is present at the uterine cornu. Each ovary measures 2 cm. in longest diameter.

The left ovary contains a hemorrhagic area over the distal half. On section this hemorrhagic infiltration extends into the substance of the ovary for a distance of one-



FIG. 1.—(Case I.) Papillary adenocarcinoma of the fallopian tube ($\times 100$).

fifth Mm. The remaining portion is made up of round yellowish firm corpus luteum structure. The right ovary shows a cyst-like structure at one point, the lining of which is moist, red-pink and extends to the surface. The anterior wall of the endometrial cavity presents an irregular polypoidal appearance with the lining endometrium glistening in character. The polypoid areas are soft and cystic-like in consistency. The myometrium through this point is gray-pink in color and of normal, soft consistency. There is a small subserous pedunculated nodule over the posterior portion of the body which measures 5 Mm. in diameter.

Microscopic Examination.—Uterus: The endometrium is the seat of a marked glandular hyperplasia. Section through the left cornual region shows the presence of a number of endometrial gland inclusions within the muscular layer. Portions of the wall here are completely hyalinized, while others are necrotic and infiltrated with polymorphonuclears. This reaction is found in a fairly well circumscribed area of degenerating fibromyomatous structure. The right tube shows no changes other than flattening of the papillae and peritubal extravasation of blood.

Left ovary: There are numerous corpora albicantes and very marked hyalinization and sclerosis of the ovarian vessels. One portion contains follicular cysts, several of which show papillary cystadenomatous changes.

The right ovary shows changes similar to the left ovary. *Diagnosis:* (1) Glandular hyperplasia of endometrium. (2) Degenerating fibromyoma uteri. (3) Papillary cyst adenoma of ovaries, bilateral.

The patient made an uneventful recovery and was discharged February 10. She then received postoperative roentgen ray therapy consisting of 1,720 R units to the lower abdomen.

CASE II.—M. R., a white adult female, aged 39, was admitted to Prospect Heights Hospital December 1, 1931, complaining of lower abdominal pain and marked vaginal

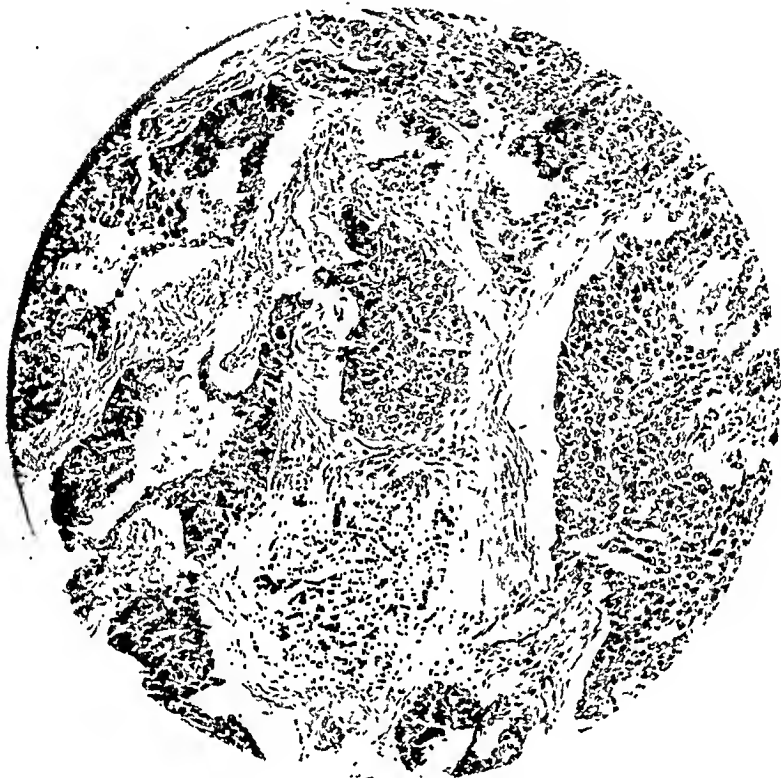


FIG. 2.—(Case II.) Papillary adenocarcinoma of the fallopian tube ($\times 250$).

discharge of four months' duration. Her menses began about the age of 14, were always regular. She had one child which died in infancy. No other pregnancy. Her last menstrual period was on November 27, 1931. In the past four months she had developed a marked mucopurulent discharge accompanied by lower abdominal pain, which failed to respond to any treatment. Her family and past history were irrelevant.

Physical examination revealed a white adult female, moderately developed, not acutely ill. Temperature 99°, pulse 80, respirations 20. Pelvic examination revealed the cervix slightly displaced to the left by a cystic mass in the right fornix intimately adherent to the body of the uterus, which was retroverted and extended about two fingers above the symphysis. There was a great deal of tenderness and pain in the right lower quadrant on bimanual examination; this was increased on manipulation of the cervix, which was slightly crooked, nodular, and exuded a mucopurulent odorless discharge. The rest of the physical examination did not reveal any pathologic findings. Heart and lungs normal.

The urine showed a slight amount of albumen, otherwise negative. Hemoglobin

72 per cent, red blood cells 3,780,000, white cells 10,000, 86 per cent polymorphonuclears and 14 per cent monocytes, 4 per cent band cells and color index 0.97.

December 3 she was operated upon by Doctor Gainey. The abdomen was opened through a low median incision and explored. Both tubes and ovaries were found intimately adherent to the uterus. The right tube was distended with fluid. Its fimbriated end contained a yellowish white solid mass about the size of a small orange, and was sealed up by the ovary, which was closely adherent to the ostium. The left tube was only slightly distended. Both ovaries were small and fibrocystic in character. The uterus was hard, firm, and covered with small fibroids. It was found on section that its lumen was almost completely obliterated by numerous similar small fibroids.

Both tubes and ovaries were removed, followed by a supracervical hysterectomy. The pathologic report of the right fallopian tube was primary adenocarcinoma (Fig. 2). There was no other malignancy found in the rest of the pelvic organs.

The patient made an uneventful recovery and was discharged December 15, two weeks postoperative. She was free of symptoms, had gained weight, and enjoyed her daily occupation. August 28, 1933 (two years and eight months after operation), she developed symptoms of acute intestinal obstruction. She was again operated upon and a band of adhesions was found about the ileocecal region. A thorough exploration did not reveal any evidence of recurrence or metastasis. The adhesions were freed and an ileostomy performed. She died September 10 (12 days after operation) from pulmonary embolism.

SUMMARY

- (1) Three hundred twenty-three cases of primary carcinoma of the fallopian tubes were found in the literature.
- (2) It occurs in about 0.45 per cent of all genital tumors.
- (3) Chronic inflammation is believed to be a predisposing factor.
- (4) Diagnosis is extremely difficult. Even at laparotomy diagnosis is often missed unless the tumor is sectioned by the surgeon.
- (5) Symptoms of serosanguineous discharge with various menstrual disturbances and abdominal pain associated with a palpable adnexal tumor and a negative uterine curettage are important aids to the diagnosis.
- (6) Radical surgery with the removal of both tubes and ovaries and a complete hysterectomy with wide excision of broad ligaments is the treatment of choice. This is to be followed later by roentgen ray therapy.
- (7) Prognosis is very poor. Only seven cases survived longer than three years.
- (8) Two cases of primary carcinoma of the fallopian tubes are reported. One occurred in a virgin. There is only one other similar case reported in the literature.

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FRACTURES OF THE HUMERUS

ANALYSIS OF TREATMENT AND RESULTS OF 200 FRACTURES

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IN PRESENTING the salient facts derived from a careful analysis of 200 successive cases of fractures of the humerus entering Harlem Hospital in the three years prior to November, 1933, on the service of the late Dr. John Fox Connors and his successor, Dr. Charles Cassasa, an effort has been made to avoid unnecessary statistics and to demonstrate that with the treatments advocated the hospitalization period is greatly reduced, the patient is made ambulatory in traction shortly after admission, and rarely is it necessary for an open operation to be performed in order to attain good anatomic and functional results.

TABLE I

TOTALS

200 consecutive cases of fracture of the humerus in three years.
16 deaths (all due to causes other than the fracture alone).
9 A. O. R. (left hospital on own responsibility).
8 transfers (to Psychopathic and Prison Wards at Bellevue Hospital).
167 cases treated.
106 cases returned for follow up in clinics.
90 per cent satisfactory anatomic results.
89 per cent satisfactory functional results.

Of these 200 cases entering the hospital only 167 remained long enough to be treated. Of the remaining 33 who were discharged without complete treatment, eight were transferred to another hospital, and nine left the hospital at their own request. The remaining 16 cases died, but in every case the cause of death was from causes other than the fractured humerus, *i.e.*, a fractured skull, or shock, resulting from such varying causes as abdominal evisceration, extensive severe burns, multiple fractures or chronic cardiac disease.

TABLE II

ARM, AGE AND SEX INCIDENCE

Arm Left humerus fractured in 122 cases (61 per cent)
Right humerus fractured in 78 cases (39 per cent)
Females fractured left arm more frequently than males (62 per cent)
Sex Males fractured arms in 121 cases (60½ per cent)
Females fractured arms in 79 cases (39½ per cent)
Age 21 per cent (42 cases) were in children under 15 years of age.
52 per cent (104 cases) were in the working age group (15 to 50 years).
10 per cent (20 cases) were in the less active age (50 to 60 years).
17 per cent (34 cases) were in the elderly group (over 60 years).

The most frequent causative factor in these fatal cases was a fall from a high window.

Side Incidence.—The left humerus is fractured much more frequently than the right in spite of the dexterity of the major part of the population. This condition has been a constant factor during each year the statistics have been analyzed, and may be due to the fact that an individual invariably thrusts his right or stronger arm forward to ward off an impending danger. The impact of the force does not injure this extended arm but causes the person's body to be thrown by the force, and the opposite arm which is not braced to protect itself is crushed against the ground or some other hard and stable object. It is felt that only a small percentage of these fractures of the humerus were caused by direct trauma from the initial force. Sixty-one per cent (122 of the 200 cases) of the fractures were in the left arm and only 39 per cent in the right arm, and 11 of the 12 compound fractures were in the left arm.

Sex Incidence.—As to the incidence according to sex, it is perhaps quite natural that men should have comprised 60½ per cent of the cases and the females the remaining 39½ per cent. Females fractured their left arms slightly more frequently than did the males.

Age Incidence.—With regard to the age incidence, 52 per cent of the cases were in people of the working age (namely, between 15 and 50 years), 21 per cent were in children, 17 per cent in people between 50 and 60 years and naturally less active, while only 10 per cent were in people over 60 years of age.

Site of Fracture.—The location or site of fracture, strangely enough, varies with the age of the patient, for the older the patient the higher the level of the fracture, and inversely the younger the patient the lower is the usual level of the site of the fracture. Fractures below the upper third of the humerus are relatively few in people older than the working age. Fractures of the shaft form 58 per cent of these fractures in people of the working age, while the most common arm injury in children is a supracondylar fracture.

TABLE III

LOCATION OF THE FRACTURE (SITE)

Head (alone).....	1
Head and surgical neck.....	3
Surgical neck or anatomic neck.....	37
Surgical neck and greater tuberosity.....	15
Surgical neck and upper shaft.....	2
Surgical neck and supracondylar.....	1
Greater tuberosity.....	13
Greater tuberosity and upper shaft.....	2
Upper third of shaft.....	14
Middle third of shaft.....	60
Lower third of shaft.....	16
Supracondylar.....	29
Internal condyle.....	4
External condyle.....	3

FRACTURES OF THE HUMERUS

TABLE IV

LOCATION OF THE FRACTURE (PERCENTAGE)

Fraetures of the head of the humerus.....	4 (2 per cent)
Fraetures of the surgical neck of the humerus.....	57 (28½ per cent)
Fraetures of the greater tuberosity of the humerus.....	30 (15 per cent)
Fraetures of the upper extremity of the humerus.....	73 (36½ per cent)
Fraetures of the upper third of the humerus.....	87 (43½ per cent)
Fraetures of the middle third of the humerus.....	60 (30 per cent)
Fraetures of the lower third of the humerus.....	53 (26½ per cent)
Fraetures of the lower extremity of the humerus.....	37 (18½ per cent)
Fraetures of the shaft of the humerus.....	92 (46 per cent)

TABLE V

LOCATION OF THE FRACTURE (ANALYSIS)

- (A) The site of fraeture tends to be higher in the bone the older the patient, and, inversely, lower in the bone the younger the patient.
- (B) Fraetures of the shaft are most common in persons of working age, forming 58 per cent of this group of eases.
- (C) Fractures of the upper third are most eommon over 50 years of age.
- (D) Fractures of and above the eondyles are most common in children and least eommon in the elderly.

Complications.—Complications of these are of two main types, direct complications, pertaining to the fractured humerus itself, and indirect complications, referring to injuries and fractures of other parts of the body, or severe medical ailments or diseases.

TABLE VI

309 COMPLICATIONS OF FRACTURES OF THE HUMERUS

85 *Direct Complications*

- 21 eompound fraetures (12 of the 21 treated).
- 29 intra-articular fraetures.
- 12 disloeations of the shoulder.
- 7 pathologie fraetures.
- 16 nerve injuries (radial 13, ulnar 2, median 1).

224 *Indirect Complications*

- 171 additional bones fraetured.
- 53 internal or eerebral injuries.
- 46 cases were uneomplicated.
- 47 eases had direct and indireet complications.
- 154 were complicated.

The direct complications numbered 85 in all, comprising 21 cases of compound fractures (10½ per cent); seven were pathologic fractures (3½ per cent); 29 intra-articular fractures; while 12 cases had an associated dislocation of the head of the bone (6 per cent), and 16 cases caused a resultant nerve injury (8 per cent).

(A) Of the compound fractures 12 remained to be treated and of these 12 cases only one case became infected and 11 healed cleanly. Of the

21 compound fractures, seven died on admission from other or multiple causes, two left the hospital either on their own responsibility or on transfer, and 12 remained to be treated (11 were in left arm and 11 in males). Seventy-five per cent had good anatomic results and 78 per cent had good functional results. No case of compound fracture of the humerus who survived his other injuries was admitted to Harlem Hospital between October, 1931, and November, 1933. This is significant, since it was at the beginning of this time that an order to all ambulance surgeons to apply traction in a Thomas splint to all fracture cases before transporting them was rigidly enforced. This application of emergency traction in a Thomas splint has prevented many complications, in addition to making the patient more comfortable while being transported, and the reduction of the fracture more simple by preventing overriding and angulation of the fragments which were of common occurrence when the old wooden side arm splints were applied previously.

TABLE VII

COMPOUND FRACTURES TREATED

12 cases treated	No deaths	1 infection (pyo.).
11 in males	11 in left arm	Average age, 30 years.

Results

75% had good anatomic results.
78% had good functional results.

Nine additional cases were transferred to the Psychopathic Ward at Bellevue Hospital or died on admission from internal or other causes.

(B) Of the 12 cases of dislocation of the head of the humerus 11 were in the left arm. Four of these cases had an associated fracture of the surgical neck and necessitated open operations for the removal of the head of the bone and insertion of the shaft in the glenoid fossa but always with the same resultant, relatively unsatisfactory functional result. The remaining eight of these cases had fractures of the greater tuberosity and traction in a Thomas splint without any previous manipulation cured both the dislocation and the fracture.

(C) The 29 intra-articular fractures all necessitated careful observation and the institution of movement at an early date so as to prevent stiff joints which would hinder a good functional result.

(D) The seven pathologic fractures were due to chronic cystic degeneration of the bone in five cases, a metastatic carcinoma in one instance and in another a chronic osteomyelitis. Five of these seven cases were in the left arm.

(E) Of the 16 nerve injuries, 13 were paralyses of the radial nerve. One case was a paralysis of the median nerve and the two remaining cases were traumatized ulna nerves. The function, both motor and sensory, returned in every nerve injury case which was observed in the follow up clinic, without

being operated upon. Patience, careful observation and physiotherapy is needed during the six to 12 months which it takes these paralyzed nerves to regenerate and regain their lost function.

(F) Two patients had both the right and left humerus fractured, which naturally greatly complicated their treatment.

(G) The indirect complications were manifold and varied from 171 fractures of other bones in other limbs to 53 internal injuries and medical diseases. They totaled 224 in number, and greatly retarded the patient's eventual recovery and in most instances prolonged somewhat the hospitalization time of the patient. Fractures of the ribs, clavicles and bones of the forearm were the most frequent additional injuries. Thirty-six bones were broken in the lower limbs and exactly half of these were on the same side of the body as the fractured humerus. Skull fractures were relatively rare. Forty-seven cases had both direct and indirect complications associated with the fracture of the humerus. At Harlem Hospital syphilis is not considered a complicating factor in the healing of fractures.

Hospitalization Time.—The length of the hospitalization time varies considerably with the site of fracture and whether or not there were any complicating factors associated with the treatment, such as fractures of other long bones, which by their very nature take longer to heal solidly than do fractures of the humerus. In most instances complications more than doubled the hospitalization time for a patient. For example, in 59 fractures of the upper end of the humerus, 28 were in uncomplicated cases who had a hospitalization period of 16 days, while in 31 complicated cases of similar nature the stay in the hospital was prolonged to 38 days. Then, too, in 56 fractures of the shaft, 25 uncomplicated cases remained only 30 days while the complicated cases stayed for 53 days. The difference is even greater when comparisons are made in 27 cases of the lower end of the humerus where 20 uncomplicated cases were hospitalized for an average period of six and two-thirds days, but the seven complicated cases averaged 27 days each, which is nearly four times as great a length of time. The seven pathologic fractures all had relatively short stays in the hospital, averaging only 20½ days. This is due in a great measure to the fact that it was necessary to immobilize these cases completely in plaster spicas, after first accomplishing the reduction and early union by means of traction in a Thomas splint. These patients were usually discharged to the clinic in their plaster spicas, as firm union is usually delayed because of the intrinsic bone disease.

The 12 compound fractures were divided into seven uncomplicated cases, with an average hospitalization time of 34 days, and five complicated cases whose recovery in the hospital was prolonged to 65 days.

Hospitalization Time Influenced by Type of Traction Used in Shaft Fractures.—The length of the hospitalization time in fractures of the shaft of the humerus also varied greatly as did the final results with the type of traction which was used in treating the different cases. Although the number of shaft fractures is not sufficiently large to draw any definite conclusions,

TABLE VIII

AVERAGE HOSPITALIZATION TIME INFLUENCED BY COMPLICATIONS

142 simple fractures	59 upper extremity	{ 28 uncomplicated cases 2 wks. (16 days). 31 complicated cases 5½ wks. (38½ days).
	56 shaft	{ 25 uncomplicated cases 4 wks. (30 days). 31 complicated cases 7½ wks. (53 days).
	27 lower extremity	{ 20 uncomplicated cases 1 wk. (6½ days). 7 complicated cases 4 wks. (27 days).
12 compound fractures		{ 7 uncomplicated cases 5 wks. (34 days). 5 complicated cases 9 wks. (65 days).
7 pathologic fractures		{ 7 uncomplicated cases 3 wks. (20½ days). 0 complicated cases

our results are quite significant and are indicative of the problem confronting hospitals which have an extremely active traumatic service. The average hospitalization time for this type of fracture was lowest when the fracture was treated by "Spanish Windlass Traction in a Thomas Arm Splint," in spite of the fact that this method of treatment was used on those patients who are most difficult to treat and in whom it might reasonably be expected that the results would not be so favorable, nor more quickly obtainable; namely, in the elderly, children, the psychopathic, and patients with compound fractures. The average time for such fractures was 38½ days; while with (Blake's) "Balanced Traction," used only in cases giving a most favorable prognosis, the average time was 41½ days. Only one of the 39 cases treated in "Thomas Splint Traction" was discharged from the wards in a secondary plaster splint because of insecure union, while six of the 15 cases treated in "Balanced Traction" had to be discharged with the secondary plaster splints, this in spite of a more favorable prognosis and a longer hospitalization time. A third method of treatment, "Skeletal Traction," was used in three cases but was quickly abandoned as the results were unsatisfactory, and an added danger of compounding the fracture by insertion of the Kirschner wire, through either the condyles of the humerus or the upper end of the ulna, was deemed an unnecessary procedure which could be dispensed with in favor of the more successful, the simpler, and far less dangerous "Thomas Arm Splint Traction." Add to these already convincing facts that cases treated by "Balanced Traction" gave a very poor percentage of satisfactory anatomic results, as six had unsatisfactory results and only nine of the 15 cases had good results, giving a low rate of 60 per cent satisfactory anatomic results, while the functional results were also somewhat lower than the average. Of the three cases treated with "Skeletal Traction," two had the Kirschner wire inserted through the upper third of the ulna and these both had unsatisfactory functional results and one of these had a poor anatomic

result. The one case in which the Kirschner wire was inserted through the condyles of the humerus had a good anatomic and functional result.

TABLE IX

TIME FOR TYPE OF TRACTION IN SHAFT FRACTURES

39 cases treated in "Thomas Arm Splint Windlass Traction"

Average time in hospital—38½ days.

Used in all types of cases of all ages.

Only one secondary plaster splint upon discharge.

Patient is ambulatory; gives the best results, easiest to apply, easiest to supervise.

15 cases treated in (Blake's) "Balanced Traction"

Average time in hospital—42½ days.

Six secondary plaster splints upon discharge.

Only 60 per cent good anatomic results (lower than the average).

3 cases treated in "Skeletal Traction"

Average time in hospital—39 days.

Two cases had wire through the ulna; poor results.

One case had wire through the condyle; good result.

Bony Union.—The length of time necessary to obtain firm bony union is dependent upon: (1) The age of the patient. (2) The type of fracture. (3) The part of the bone fractured. To these might be added the further factors of: (4) The cooperation of the patient. (5) The skill of the surgeon in manipulating the bony fragments into a satisfactory position so that union may progress more favorably.

Union is somewhat delayed in the elderly, and is usually accelerated in children and robust men of working age. It occurs more rapidly as a rule in comminuted fractures where more blood channels are opened up and an increased amount of free calcium is deposited locally about the area in which the callus is to form. Union apparently is most quickly obtained in supra-condylar fractures, partly because of the ample blood supply to this part of the bone and partly because this type of fracture is most frequently seen in children.

Ninety-three of our 167 cases were discharged to the clinic in splints, within two weeks from the day of admission, because their particular fracture no longer needed hospital care but could be ably treated and followed up in the clinic; 18 cases had inconclusive records as to this condition; two cases both with surgical neck fractures were discharged after long confinement, with apparent nonunion, but one of these cases was observed three months later in a follow up, and at that time she had fair union and good function of her arm. This leaves only one known case in which union had not taken place when last observed, and this patient had a follow up of only two months from the date of injury.

Open Operations.—Open operations for the correction of fracture deformities gave very favorable functional results. The unsatisfactory results were due to a certain extent to the nature of the injuries, for of the nine

TABLE X

BONY UNION

93 cases discharged from wards with bony union.

42 cases discharged within 2 weeks to the clinic.

18 cases had records which were inconclusive as to union.

1 case (surgical neck) had delayed union (3 months later had good function—fibrous union).

1 case (surgical neck) had no union (when last observed by us 2 months after injury).

cases operated upon, four were cases in which the surgical neck was fractured and the head of the bone was dislocated. In this type of injury all forms of manipulation and traction are useless and it is often necessary to operate to remove the head of the bone and to insert the upper end in the glenoid fossa. Although these four operations were performed without mishap and the best anatomic results possible obtained, the functional results were not very gratifying. They would probably have been worse if operation had not been resorted to. The remaining five cases which were operated upon all gave satisfactory anatomic and functional results and were performed only when closed reduction was deemed unwise or had been unsuccessful. With the exception of these four cases where the useless head was excised and one case of a badly comminuted compound fracture, which necessitated the removal of a fragment of bone, only four open operations were performed in 162 cases ($2\frac{1}{2}$ per cent).

Anatomic Results.—The anatomic results in 150 of the 167 cases were satisfactory and give an average of 90 per cent (Table XI). The best results were obtained in 34 fractures of the lower end of the bone where 97 per cent successful results were had; next come the 56 fractures of the upper end of the bone where good position was obtained in 90 per cent of the cases, and last were the 60 fractures of the shaft of the bone which were manipulated into a correct position and united in $85\frac{1}{2}$ per cent of this type of case. No doubt this percentage would have been even higher if the only form of traction used had been a "Thomas Arm Splint Traction." Seven cases had some bony deformity, six of these had only slight deformity and one a moderate degree of displacement and angulation. Of the 17 unsatisfactory results, 13 were classified as fair and four as poor. Nine of the fair results were in fractures of the shaft, two were in the surgical neck and one was supracondylar. Six of the nine unsatisfactory shaft results were treated in "Balanced Traction," leaving only three of such cases which were treated by the often used "Thomas Splint Traction," and of these three one was a pathologic fracture (osteofibrosis cystica), in which the cystic degenerative changes in the bone became worse, one was a compound fracture of the upper shaft which resulted in a 2 cm. shortening of the bone but a good functional result, while the third case was that of a patient 61 years old who had a Colles fracture of the same limb but who also had a good functional result. The remaining four fair results were in cases already described

where there was a dislocation of the head associated with a fracture of the surgical neck and for which open operations were performed to remove the useless and displaced head of the bone and to place the upper end of the shaft in the glenoid fossa. Three of the four poor anatomic results were fractures of the surgical neck with marked displacement of the shaft, and the fourth was a compound supracondylar fracture which developed osteomyelitis and necessitated removal of part of the lower end of the bone.

TABLE XI

ANATOMIC RESULTS

90 per cent (150 cases) had satisfactory results

150 satisfactory; 90 per cent	{ 83 excellent results. 67 good results.	{	56 upper extremity, 90	per cent satisfactory.
			60 shaft extremity, 85 1/4	per cent satisfactory.
			97 lower extremity, 97	per cent satisfactory.
17 unsatisfactory	{ 13 fair results. 4 poor results.	{	6 upper extremity, 10	per cent unsatisfactory.
			10 shaft extremity, 14 1/2	per cent unsatisfactory.
			1 lower extremity, 3	per cent unsatisfactory.

One case had no union when last observed.

One case had delayed union but good function with fibrous union.

Seven cases some bony deformity (usually slight).

Sixteen cases had nerve injuries (none operated upon).

Functional Results.—The functional results based on a follow up of 106 of the 167 patients whose anatomic results have been cited above or (63 1/2 per cent follow up) gave a slightly less satisfactory percentage of good results than did the anatomic results. However, the percentage of 88 7/10 is gratifying. Of the 94 satisfactory functional results the best percentage was had in the 41 fractures of the shaft of the bone where 92 1/2 per cent good results were recorded. It is worthy of note that it was these same fractures of the shaft which gave the most unfavorable anatomic results when compared to fractures elsewhere in the bone. Fractures of the lower extremity are rated next in the functional results as in 25 cases good results were obtained in 88 per cent. The least satisfactory functional results were in the 40 fractures of the upper extremity of the bone which attained a rating of only 85 per cent. All adult cases with unsatisfactory results had the injury in the left arm (11 of the 12 cases). The remaining case was a supracondylar fracture in the right arm of a child who did not continue with his physiotherapy treatment in the clinic after discharge.

Of the 12 unsatisfactory functional results nine were classified as fair and three as poor. The three poor results were all in fractures of the surgical neck, but the nine fair results were equally divided with three each in the upper end, the shaft, and the lower end of the bone. Therefore, six of the 12 unsatisfactory functional results were in fractures of the surgical neck of the bone, but of these six cases four were cases which had a concomitant dislocation of the head of the bone and another was the one case of nonunion already mentioned. In fractures of the shaft better functional

results were observed in those cases treated in "Thomas Arm Splint" with "Spanish Windlass Traction" than in those cases treated in either "Balanced Traction" or "Skeletal Traction." Two of these midshaft fractures (one treated in Thomas splint traction and one in "Balanced Traction") had unsatisfactory anatomic results. In the two cases treated by a Kirschner wire through the ulna (for skeletal traction), the functional results were both poor, while in the one case with the wire inserted through the humeral condyles the function was satisfactory. The average hospitalization time for the patients with unsatisfactory functional results was 47 days, for satisfactory results 35 days.

Although there were 85 direct complications, consisting of nerve injuries, cystic degenerations of the bone, compounding wounds, dislocations and intra-articular fractures, the satisfactory functional results were 89 per cent. Of the unsatisfactory functional results five were in cases who had open operations and two were in cases of skeletal traction through the ulna. In addition there were 171 other bones fractured in the body and there were 53 cerebral or internal complications of serious importance, all of which had to be treated at the same time as the fracture of the humerus. It is only natural that the functional results under discussion were somewhat impaired in the effort to save the patient's life or prevent any serious deformity as a result of his many injuries (Table XII).

TABLE XII

FUNCTIONAL RESULTS

89 per cent (90 of 106 cases) had satisfactory results based on a follow up of 106 cases.

94 satisfactory; 89 per cent	{ 34 upper extremity, 85 per cent satisfactory results.	
	{ 38 shaft extremity, 92½ per cent satisfactory results.	
	{ 22 lower extremity, 88 per cent satisfactory results.	
12 unsatisfactory; 11 per cent	{ 6 upper extremity, 15 per cent unsatisfactory results (3 fair—3 poor).	
	{ 3 shaft, 7½ per cent unsatisfactory results (fair).	
	{ 3 lower extremity, 12 per cent unsatisfactory results (fair).	

Six of the twelve unsatisfactory results were in the surgical neck.

The only three poor results were in the surgical neck.

Four unsatisfactory results were after open operation.

Two unsatisfactory results were after skeletal traction.

Eleven of the twelve cases were in the left arm.

Treatment.—The type of treatment which should be used varies greatly with the regimen of the particular hospital, and the amount of supervision each case can be given, and also with the location of the fracture. Fractures in the surgical neck are best treated in "Thomas Splint Traction," but when associated with a dislocation of the head of the bone an open operation may have to be resorted to, so that the displaced and useless head may be removed and the upper end of the shaft inserted in the glenoid fossa.

This type of case and compound fractures are in our opinion the only indications for operation at an early date.

Impacted fractures of the surgical neck with the fragments in good position can usually be treated satisfactorily in a Velpeau bandage without any previous traction.

Fractures of the greater tuberosity likewise are usually easily treated in a Velpeau bandage, but if displacement of the fragments or a dislocation of the head of the bone exists, traction in a Thomas splint will be necessary, and this form of treatment has never failed in reducing both the fracture and the dislocation.

Fractures of the shaft, as has already been shown, are best treated in hospitals which have a very active traumatic service, by means of "Spanish Windlass Traction in a Thomas Arm Splint" applied over a plaster buttress (Fig. 1), which will protect the axillary structures from the trauma of the

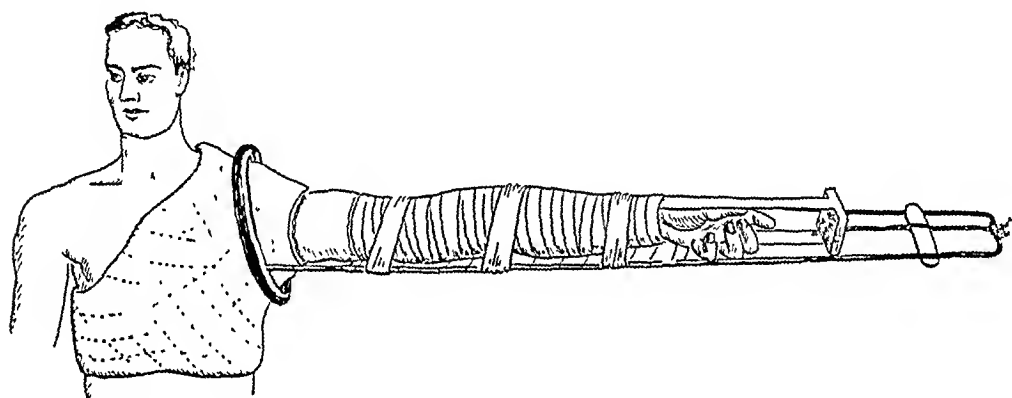


FIG. 1.—Illustrates the method of employment of the "Spanish Windlass Traction in a Thomas Arm Splint."

ring of the splint and will diffuse the resultant pressure of the traction away from the axilla and over the whole lateral chest wall. This method of treatment makes it possible to get the patient out of bed within two weeks without any danger of disturbing the position of the fragments. It is easily applied and adjusted and greatly simplifies supervision by the ward nurses and the doctors; in addition it immobilizes the fragments better than any other form of traction and gives firmer union more quickly and has terminated with better anatomic and functional results in our experience. Open operation for a shaft fracture should rarely, if ever, be necessary, and in this series there was only one such case in which control of the fragments was lost while endeavoring to apply a plaster splint at too early a date, after having obtained an excellent anatomic position by "Thomas Splint Traction." If there should be a lateral displacement of the fragments which was not corrected by this traction, then two small slings or cuffs passed about the arm above and below the fracture site and tightened to the opposing side bars of the splint will usually remedy the situation.

Supracondylar fractures should have an immediate reduction of the fragments under anesthesia. Reduction is best accomplished by applying

steady manual traction and then manipulating the fragments into place and acutely flexing the forearm on the arm in a Jones position to lock the fragments in place by the action of the triceps muscle. If manipulation proves unsuccessful, traction in a Thomas splint gives a good result, but increases the hospitalization time. Motion should be begun in these cases at a very early date, just as it is in intra-articular fractures.

Compound fractures necessitate an immediate débridement of the wound and either a packing of the wound with gauze, if a loss of skin substance exists, or immediate suturing. The fracture is then treated as any simple fracture of the same type.

In cases where an associated nerve injury exists, the fracture should be treated as though it were uncomplicated. If it be definitely known that the nerve has been completely severed and not merely crushed, then it will be necessary to suture the nerve as soon as all danger of compounding the fracture has passed. However, in this series of cases no such condition presented itself. In 16 cases of nerve injuries, suturing was never necessary and function returned to all cases who were observed in our follow up clinic. If there is any doubt as to whether or not the nerve is severed it is best to err on the side of being conservative and not operate for at least six months and then only when no sign of regeneration has occurred. If the radial nerve is the injured member it is best to apply a "cock-up" splint to support the extensor muscles and prevent them becoming over stretched while awaiting the return of the nerve function. All muscles supplied by a nerve which has been traumatized should receive frequent physiotherapy.

CONCLUSIONS

(1) The site of the fracture tends to vary with the age of the patient, for the older the patient the higher the level of fracture and the younger the patient the lower is the level of the fracture. The midshaft was the most frequent site for patients within the working age group.

(2) (a) Sixty-one per cent of the fractures of the humerus were in the left arm.

(b) Eleven of the 12 compound fractures were in the left arm.

(c) Eleven of the 12 dislocations of the head of the humerus were in the left arm.

(d) Eleven of the 12 unsatisfactory functional results were in the left arm.

(e) Five of the seven pathologic fractures were in the left arm.

(3) A buttress spica will protect the axillary nerve structures and also make the patient more comfortable as it diffuses the pressure of the ring of the splint over the whole lateral chest wall, and it will also permit making the patient ambulatory at an earlier date.

(4) Do not use skeletal traction through the ulna as traction on the forearm with the elbow flexed apparently strains the ligaments and impairs function of the elbow joint.

FRACTURES OF THE HUMERUS

(5) Early reduction under anesthesia is the treatment of choice for supracondylar fractures. Immobilize in Jones position and start physiotherapy and motion at an early date to obtain good functional results.

(6) Open operations should rarely be necessary to obtain good results.

(7) In compound fractures do an immediate débridement and then treat your fracture as if it had not been compounded. The results will be excellent if conservatism is practiced (11 of the 12 cases of this series healed cleanly).

(8) Institute physiotherapy treatment early. It stimulates callus formation while the arm is in traction and facilitates function later. This is especially so now since diathermy has become so successful and to a great extent has replaced baking and massage.

(9) In our experience the "Thomas Splint Traction" gives better union more quickly and necessitates a shorter hospitalization period. It can be used in all types of fractures both as an emergency measure and as a method of treatment and in all types of patients of all ages. Its use resulted in the best anatomic and functional results. In hospitals where a less active service is found, and in those whose endowments permit more nursing supervision, it is quite likely that the treatment of choice in many instances would be the "Balanced Traction."

(10) The predominating factors in our unsatisfactory results, both anatomic and functional, were (a) the presence of a dislocation of the head of the bone associated with a fracture of the surgical neck; (b) the lack of cooperation by patients who were either chronic alcoholics or mental cases; (c) the multiplicity of the various complications, both direct and indirect; (d) the institution of skeletal traction through the ulna with the elbow flexed; and (e) the severity of comminution or compounding of the fracture itself.

(11) Our best anatomic results were obtained in supracondylar fractures and the worst in fractures of the shaft. The best functional results were obtained in shaft fractures and the worst in fractures of the upper extremity of the bone. Fractures of the shaft, therefore, gave the lowest percentage of satisfactory anatomic results but the highest percentage of functional results.

(12) Finally with these simple and inexpensive methods of treatment we obtained 90 per cent satisfactory anatomic results; 89 per cent satisfactory functional results; and had only one case of nonunion.

OSTEITIS PUBIS FOLLOWING SUPRAPUBIC PROSTATECTOMY

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A SURVEY of the literature reveals an astonishing paucity of cases of osteitis of the pubis following suprapubic prostatectomy. It is even more surprising to note how little orthopedists and interns know about this clinical entity. It may be that this condition is rare, but it seems more likely that some, due to their mild character, are completely overlooked, and the others incorrectly diagnosed.

Thirteen years ago I noted within an interval of a few months two cases of severe pain over the symphysis pubis with adductor spasm of the thighs. Both of these cases were in men in the late sixties, following a two stage suprapubic prostatectomy. The complication occurred a few weeks following their discharge from the hospital. Having had no experience with this condition, it was believed that we were dealing with metastases involving the symphysis pubis from glands which, though clinically benign, might have actually been malignant. In one of the cases, due to the severity of the symptoms and signs, it was believed that we were dealing with an osteomyelitis of the pubis, and an exploratory operation was performed, but nothing of note found. With the view that these cases were hopeless, both were placed upon sedatives, and after a prolonged period of confinement to bed, the symptoms and signs completely disappeared.

Aschner states that this complication was also encountered after suprapubic operations upon the bladder other than prostatectomies. Beer¹ first encountered it in 1916. The only mention made of this clinical entity in textbooks on urology is by H. Cabot.² It appears that the complication only follows suprapubic operations in which the bladder is opened. It is difficult to state the exact cause of the inflammation of the periosteum and bone. Beer mentions the possibility of compression injury of the pubis by retractors in the course of the operative procedure, and also pressure due to the suprapubic drainage tube. These seem very unlikely since in the case herein described the operation was extremely simple, requiring but very little retraction, and the drainage tube was not large and made of soft rubber.

Symptoms.—Symptoms usually arise from two to three weeks after the enucleation, beginning with pain in the lower angle of the wound which grows severe when the patient attempts to sit up and when coughing or sneezing. This is due to pulling of the recti abdominis muscles against the inflamed periosteum of the symphysis to which they are attached. As the disease progresses the pain involves the body and descending rami of the pubis and the adductor muscles attached to this part of the pelvis, so that walking and separation of the thighs becomes extremely painful. Patients

have a peculiar wabbling gait. Each step is taken deliberately with the aid of a cane or crutch, since the slightest jarring greatly aggravates the pain. The patient finds it extremely difficult to move about in bed, and also experi-

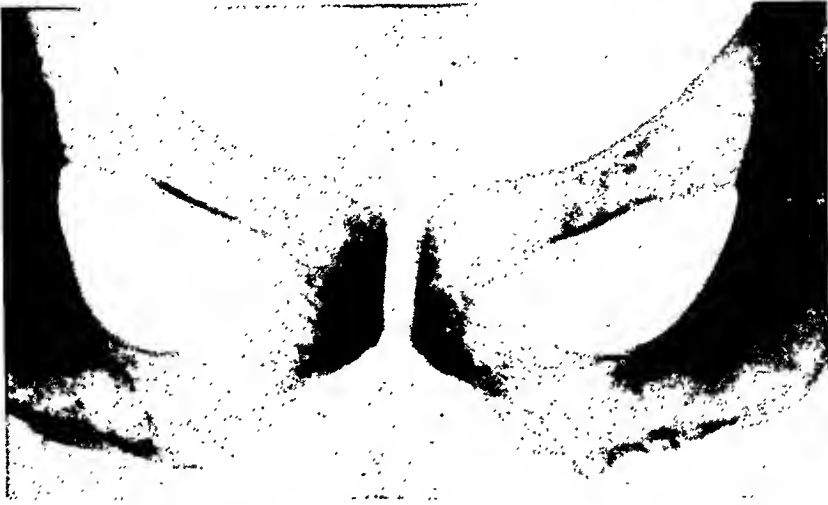


FIG. 1.—Radiogram of the pelvis taken October 24, 1933, the onset of the illness, showing beginning erosion of the upper margin of the symphysis pubis.

ences intense pain in the thighs and lower abdomen during defecation or at the end of micturition.

The temperature may show a slight to a moderate elevation. On examination one usually elicits exquisite tenderness over the symphysis pubis, over



FIG. 2.—Radiogram of the pelvis taken November 25, 1933, showing a more extensive erosion of the symphysis pubis.

the lower attachment of the recti abdominis muscles, over the body of the descending rami of the pubis, and over the adductor muscles of the thighs. As the process advances, the temperature drops to normal but the signs and symptoms progress.

A roentgenogram taken in the early stages of the disease may show nothing at all, or only a slight fraying of the superior corners of the symphysis.



FIG. 3.—Radiogram of the pelvis taken December 8, 1933, showing still further destruction of the symphysis pubis with a tendency toward a V shaped defect in the symphysis.

Later one notices a definite rarefaction of the body and descending ramus of the pubis, and it is in this stage that the unwary will diagnose the process,



FIG. 4.—Radiogram of the pelvis taken December 23, 1933, showing a leveling out of the destructive process of the symphysis, giving the appearance of a separation of this portion of the pelvis.

especially when the temperature is elevated, as an osteomyelitis and advise surgical intervention; or when the temperature is normal the osteoporosis

will be looked upon as due to metastatic deposits. The next stage is an absorption of the symphysis beginning at the superior border and advancing caudad to the inferior pubic arch, so that a V shaped defect can be seen. Later, as the absorption continues, the picture is that of a separation of the symphysis. Although in a few of the reported cases the process has gone on to bone necrosis with formation of a sequestrum, this is the exception rather than the rule.

The disease must be differentiated from osteomyelitis and from metastatic involvement of the pubis. To one who has never been confronted with this clinical entity, the differential diagnosis is difficult. In the early stages, the symptoms and signs, coupled with positive roentgenographic evidence of bone destruction and fever, make the diagnosis of osteomyelitis very suggestive. In the later stages, in the absence of fever, but with the roentgenographic evidence of extensive osteoporosis, one is strongly led to suspect metastatic deposits. To one who has had experience with this complication the diagnosis of osteitis pubis stands until disproved. Should the process prove to be due to osteomyelitis, the temperature will remain elevated or rise, and a sequestrum will be thrown off and an abscess eventually form. In the event the lesion is due to metastases, other symptoms will become manifest, such as cachexia and loss of weight. The roentgenogram will also disclose areas of osteosclerosis along with osteoporosis, particularly around the sacroiliac joints.

As regards treatment, it must be understood that the disease is a self-limited one, and there is no specific curative agent. The most important feature in such a patient is to see that no one attempts operative intervention, except in cases where an abscess develops which requires evacuation, and these are extremely rare. Since there are no specific measures available, the treatment consists of such palliative measures as rest in bed, baking, massage, and hot sitz baths. In the severe cases the best treatment is the application of a plaster case reaching from the midabdomen over both legs as far as the ankles. The diet should be rich in vitamins and should contain an abundance of calcium. Symptoms may persist from two to six months and then recede.

CASE REPORT

N. E. B., a physician, aged 56, was first seen August 23, 1933, complaining of difficulty in starting urination and nocturia, over a period of several years. Cysto-urethroscopic examination revealed a marked enlargement of the middle and lateral lobes of the prostate. Residual urine one and one-half ounces. Following the examination the patient had chills and fever of 105° lasting 48 hours, following which the temperature receded to normal. Physical examination was essentially negative save for an enlarged, elastic prostate gland felt per rectum.

August 28, 1933, under spinal anesthesia, a suprapubic cystotomy was performed and a medium sized soft rubber drainage tube introduced into the bladder. Following the operation the patient did very well, and September 13, under spinal anesthesia, the prostate was enucleated in one piece without difficulty. Two small packings were left in the prostatic bed which were removed after 48 hours. The patient passed through a smooth, uneventful, afebrile convalescence and began to void on the seventh day, and

was discharged from the hospital September 26. The pathologic diagnosis of the specimen was glandular (cystic) hypertrophy of the prostate.

About one week after leaving the hospital, which was about three weeks after the prostatic enucleation, he began to experience pain in the left suprapubic region intensified by movement, coughing and walking. He also noted a dull pulling sensation in both lower extremities, particularly the left, and over the inner aspects of the thighs and calves. The pain was just as severe at night as during the day, and was aggravated by the slightest motion. At the end of urination he experienced spasmodic contractions of the adductor muscles of the thighs with pain reaching down to the calves. The pain was more severe on the left side.

The physical findings October 30 revealed the patient walking with the aid of a cane with great difficulty, the gait being wobbly. Difficulty was also noted in sitting and arising. There was a 60 degree flexion contracture of the left hip with marked spasm of the adductor muscles. There was a slight atrophy of the left thigh. Palpation of the pubis revealed exquisite tenderness over the symphysis, the lower ends of the rectus muscles and the left ramus of the pubic. There was no evidence of abscess

formation, nor was there any limitation of motion of the right hip. The temperature was 99.4°. A roentgenogram (Fig. 1) disclosed a haziness and beginning bone destruction of the left pubis.

For about two weeks the symptoms became much more severe, so that he found it increasingly difficult to get about. The temperature reached as high as 101°, following which it became normal for the remainder of the disease. The pain gradually spread to the left ramus and adductor muscles and over the attachment of the recti



FIG. 5.—Radiogram of the pelvis taken November 24, 1934, showing almost complete restitution.

muscles to the symphysis. There was no indication of abscess formation during this period.

Hot baths, baking and massage failed to give relief. A plaster case reaching from the umbilicus over both thighs to just above the ankles was applied November 9. After one week the case was removed and he was given short wave length diathermy, but without appreciable relief. A second case was applied November 16, but owing to the great discomfort which it caused, it was removed one week later. Orthopedic consultants advised wiring of the symphysis because of the increasing separation; others incision and drainage on the assumption that it was an active osteomyelitis. Radiograms (Figs. 2, 3 and 4) taken at intervals revealed a progressive destruction of the symphysis.

A third plaster case was applied December 11, and left on for seven weeks, following which the symptoms rapidly disappeared. A communication on May 10 stated that he had discarded his cane and was feeling well, except for slight pain in the thighs when spreading his legs, fatigue when walking fast or exercising, and a sense of discomfort over the sacroiliac joints (Fig. 5). March 6, 1935, the patient reported that he had no further symptoms.

SUMMARY AND CONCLUSIONS

(1) Osteitis pubis is a rare complication following surgical procedures carried out on the bladder through a suprapubic incision.

(2) The etiology of the disease is unknown.

(3) The outstanding features of this complication are pain localized over the lower attachments of the recti abdominis muscles, the body, symphysis and rami of the pubic bone, the inner aspects of the thighs with adductor spasm, so that the patient finds it painful to walk, to spread the thighs, and to cough. A late symptom is pain on defecation and terminal dysuria.

(4) Fever is rarely present throughout the disease, but may be present during the early stages.

(5) Symptoms usually occur about two to three weeks after operation.

(6) The process very rarely goes on to suppuration and fistulous formation.

(7) Since the disease is a self-limited one, the treatment is palliative except in the few cases where suppuration occurs. Most of the cases will respond to baking and massage and to the application of a properly fitted plaster case.

(8) The disease is self-limited with symptoms lasting from two to six months, followed by resolution and complete recovery.

REFERENCES

¹ Beer, E.: Jour. Urol., August, 1928.

² Cabot, H.: System of Urology.

BOOK REVIEWS

DISEASES OF THE LIVER, GALLBLADDER, DUCTS AND PANCREAS. THEIR DIAGNOSIS AND TREATMENT. By Samuel Weiss, M.D. Quarto of 1099 pages, illustrated. New York, Paul B. Hoeber, Inc., 1935.

The author's "main intention has been to place before the student and general practitioner facts which will aid them in their daily contact with patients." It consists of 31 chapters and 358 illustrations and is encyclopedic in its range, bringing the literature on the liver, gallbladder, *etc.*, up to June, 1935. As a reference book it has great possibilities for usefulness. To be used for a continuous system of teaching it is overamplified and includes a surprising amount of distinctly laboratory material and technical procedure. The style adopted by the author is terse and reliance is placed to an unusual degree upon the short paragraph for the presentation of isolated clinical facts. It is occasionally very difficult to follow the relationship of a given statement with what precedes it and with what follows it—for example, on p. 141 appears: "Antitoxic Functions. The liver destroys certain toxic substances entirely, or else combines them with other substances to form non-toxic bodies which are excreted." No less than four pages farther on there appears "detoxifying protective action of the liver" where it is stated impairment of such detoxifying action may contribute to the causation of cholemia. It is interesting to note that apparently Adami's contribution on subinfection was entirely missed in the study of this liver detoxifying activity.

Chapter VI on the Indirect Examination of the Liver is well considered and contains such a wealth of material that it perhaps would be somewhat better if greater selectivity were exercised.

The economic and public health importance of the typhoid carrier would seem to merit a somewhat more extended treatment. The cure of the typhoid carrier by cholecystectomy is only incidentally mentioned. Chapter VIII on Roentgenology of the Liver, Gallbladder and Pancreas is by A. Judson Quimby and is given ample proportions and in consonance with present day teaching.

The reader is surprised that in Chapter IX, Functional Diseases of the Liver, the theory of lithemia of the vintage of 1877 should be given 17 lines and it is not without interest that "biliousness or torpid liver" is raised to the dignity of a concrete disease. On p. 276, under Classification of the Functional Derangements of the Liver, there is listed a congeries of symptoms that is strangely reminiscent of the alleged symptomatology of chronic intestinal stasis. This method is strongly suggestive of the continental system wherein a name is given to a supposed disease entity and then every possible deviation from the normal is listed under it as a symptom.

Chapter XIV—Acute Yellow Atrophy of the Liver—is very well done, except for the tendency to make categorical statements that are not in keeping

with present day thought—"Catarrhal jaundice is an infectious disease; acute yellow atrophy of the liver is an aggravated form of it." Icterus catarrhalis is neither a morbid nor pathologic entity and the icterus that is associated with the condition may be due to degenerations and multiple necrosis of the liver, hematogenous in origin but without known etiologic factors.

Chapter XXII is devoted to Jaundice and is informative but lacks a logical presentation of the essential chemistry of bilirubinemia. A broad review of the chemistry of jaundice would be especially valuable in indicating the diagnostic distinction between so called "painless jaundice" and "painful jaundice." The author has presented his own classification of jaundice based upon the etiologic factors producing it, necessitating over four pages to list all of the possible conditions that might cause jaundice. However, McNee's classification, which is by all odds the simplest and most workable, is covered in seven lines, to be followed by four paragraphs of explanation some two pages farther on.

Courvoisier is listed five times in the index of personal names yet nowhere does there appear a logical explanation of the Courvoisier gallbladder and its importance in diagnosis. Bilirubinemia is quoted once in the index and is in the text under the test for hemoglobin.

Surgery of the Gall Bladder, Bile Ducts and Liver is contributed by Dr. J. Prescott Grant and covers 36 pages and indicates the operative procedures of the contributor's personal technic. What is presented is sound and in consonance with modern surgical opinion, yet the reviewer is conscious of a lack of precise information in dealing with the complications that are encountered in gallbladder surgery and particularly in those patients who were operated upon in the presence of jaundice.

In Chapter XXVIII, devoted to Disease of the Pancreas, there is an unusual tendency to abbreviate which is not apparent in other sections of the book. Out of 40 pages devoted to diseases of the pancreas approximately 13½ pages are given to illustrations, which add little to the text and are not in themselves explanatory. The reader misses Deaver and Pfeiffer's contribution on the association of gallbladder disease and pancreatitis, as well as the contribution of Arthur Cabot on the Courvoisier Gallbladder. There are included, however, such recent contributions as the consideration of hyperinsulinism by Seale Harris and "dinitrophenol jaundice." It is to be regretted that Whipple's masterly paper on adenoma of the pancreas apparently was published too late for abstraction.

In the section on Malignant Tumors of the Pancreas, Courvoisier's name does not appear and what is of more particular interest is that the author fails to make any recommendation for treatment and the palliative operation of cholecystenterostomy is not mentioned. This is in contrast with the last sentence on p. 822, "For surgery of the pancreas the reader is referred to books dealing with the subject." This is the first distinct omission of the author's opinion on surgical indications which up to this point have been unusually sane and liberal.

Chapter XXIX, Methods of Determining Pancreatic Ferments, embraces 23 pages of text that might well have been omitted, for this material is distinctly within the province of text-books on clinical pathology.

Chapter XXX, Dietetic Management of Diseases of the Liver, Gall Bladder and Pancreas, discusses diet and assembles the various regimens that have had varying degrees of usefulness in the treatment of disease of the biliary system.

The few animadversions indicated above in no way detract from what is a splendid presentation of the subject. The collecting and collating of the material represents a stupendous labor. It is essentially an epitome of practically everything written about the subject matter as of June, 1935. The major defect of the book is the over simplification by extensive subdivisions of text. This renders it exceedingly difficult for the reader to preserve any sense of the continuing process of disease and results in a sort of interrupted pattern of diagnostic writing. It is suggested that in any subsequent edition the text be submitted to ruthless pruning, and that it be printed on lighter weight paper—as the handling of a book weighing seven and one-half pounds for any length of time, on anything but a desk, is difficult.

CHARLES GORDON HEYD, M.D.

DISEASES OF THE THYROID GLAND. ARTHUR E. HERTZLER, M.D. C. V. Mosby Co., St. Louis, 3rd edition, 1935.

In these days when most medical articles are little more than a maze of statistics and references, it is refreshing to come across a book which omits percentages and bibliography entirely and is intentionally devoted to the expression of the author's own experiences and impressions. This third edition of Doctor Hertzler's Diseases of the Thyroid Gland is thoroughly his own book, a detailed, lucid presentation of his personal conclusions, based on many years' experience with thyroid patients and close acquaintance with the practice in other leading thyroid clinics. Although the text-book character of previous editions is superficially maintained by the complete, well indexed arrangement of chapters and headings, it reads more like an original thesis. It is really a new book, having been radically revised and rewritten. Because of its personal and authoritative nature it should arouse widespread interest and criticism, and may well have considerable effect on the development of newer trends in the treatment of thyroid disease and lead to better coordination of our present ideas.

The most stimulating part of the book is probably the new introduction, entitled "General Considerations." Here, the author has aptly singled out the problems which most need discussing today—the fact that hyperthyroidism is more than simple hypersecretion of the thyroid, the problem of the interrelation of simple goiters and the toxic and degenerating types, the difficulty of relating anatomic and physiologic changes with clinical findings, and lastly the all important question of what would happen to goiters if we did not

operate upon them. The importance of personal follow up of operated and non-operated cases is, of course, stressed. The questions raised, as well as the occasional difficulty in answering them convincingly, bring forcefully to our attention the need of further research in this field.

Doctor Hertzler's solution of these problems is based on his conception of thyroid disease as a "continuous process." In agreement with this conception he proposes a new classification of thyroid affections, which has many academic merits, but which will be generally criticized as being too unwieldy for clinical use. The rest of the book suffers a little from the necessity of conforming to this classification, particularly in treating as a separate clinical entity, the "degenerated colloid goiter" as distinct from the ordinary adenomatous types of colloid goiter. The author uses as the basis for this clinical diagnosis the well known degenerative and involutionary changes found in the end stages of both toxic and non-toxic goiters, but he admits that both the clinical and pathologic findings in this group are very variable, and we are left with the impression that it is a decidedly confusing and unsatisfactory diagnosis from the point of view of the clinician. The point is well taken, however, that the markedly degenerative type of gland indicates long standing disease with attendant chronic systemic disturbances, frequently cardiac. In both the toxic and the non-toxic cases of this type, subtotal thyroidectomy usually benefits the constitutional symptoms.

The chapters on etiology and on goiter in childhood are particularly well presented. For the young thyroid surgeon, the chapters on morphology and topographic anatomy of the thyroid, as well as the chapters on hospital management of patients (written by Dr. Hertzler's resident surgeon, Victor E. Chesky, M.D.) and on operative technic should be of interest. The illustrations by Tom Jones are, of course, excellent. In Boston we would consider some of Hertzler's operative technic, such as operating without face masks, a little unorthodox, and we do not have a great deal of use for local anesthesia which he recommends exclusively. On the other hand, he is scornful of the unskilled operator who must resort to general anesthesia. The truth of the matter is that equally excellent results are obtained with several different technics and anesthetics. It is primarily the surgeon rather than the technic which is the important variable factor.

Taken all in all, this latest edition is decidedly stimulating and worth while. Any clinician interested in thyroid disease, particularly thyroid surgery, will be well repaid by reading it through and forming his own opinion regarding the problems discussed so thoroughly and competently by the author.

LEWIS S. PILCHER, 2nd, M.D.

MEMOIR

HAYWARD W. CUSHING

1854-1934

DR. HAYWARD W. CUSHING was born in Boston in 1854, was of Harvard, 1877, was graduated from the Medical School in 1882, studied abroad, served Children's, City and Carney Hospitals, was a member of all the proper things, retired in 1905, died at 80, in 1934.

Cushing's life and death bring back the tragedy of his retirement at 51, under a mistaken diagnosis of malignant disease. Professionally, that was final, though he regained and retained health and vigor and his unusual mentality nearly to the end.

The history of Doctor Cushing lies far back, before 1905, and on my desk lie the titles of publications by him in the 80's and 90's and the record of the "right angle" continuous intestinal suture, the one thing sometimes recalled today. This dates 1899.

Nephrectomy for calculi (successful), 1892; improved method for hernia operation, 1888; excision elbow under cocaine, 1887; hernia under local anesthesia, 1898, and again in 1899; typhoid cholecystitis, 1898; successful operation on wound of thoracic duct, 1898; successful operation on traumatic cyst of pancreas, 1898; jejunal fistula, 1899; splenectomy in splenic anemia, 1899; typhoid perforations, 1898; hematomyelia, 1898.

Before his retirement he knew more, had thought out more things, than the rest. He operated as he thought—slowly, carefully, but his slow operations were so planned, so carefully, so gently done that he got amazing results. His nickname of "Careful Cush" carried recognition of both these items and we held him in enormous regard. He and Elliot, also early retired, were doing intestinal surgery, for instance, in the last century and doing it well when the others could not.

A scholarly medical man, a very competent surgeon, he cared not a whit for applause, was indifferent to private practice, concerned with his professional interest and research alone. An odd type by present day standards, but we, his juniors, respected him, learned much from him, loved him.

FREDERIC JAY COTTON.

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LIVER STONES

IVAN G. RUFANOV, M.D.

MOSCOW, U.S.S.R.

TRANSLATED BY ARTHUR J. WALSCHEID, M.D., OF NEW YORK, N. Y.

FROM THE FIRST SURGICAL CLINIC OF THE SECOND MEDICAL INSTITUTE AT MOSCOW, U.S.S.R. DIRECTOR
PROF. I. G. RUFANOV, M.D.

"There is no disease of the gallbladder ducts. The only disease is that of the liver cells themselves."—Chauffard. 1890.

SEEING extensive liver changes in only mild cases of infection so astounded this talented clinician as to cause him to make the above statement. Even 40 years ago when gallbladder surgery was still in its infancy, experienced clinicians, because of apparent facts, concluded that gall duct disease, unless considered as associated with the liver parenchyma, was difficult to understand, evaluate and to establish prophylactic treatment.

Although the problem of hepatogenesis has made great progress toward solution during the last 40 years, it has not been satisfactorily, or finally, solved as yet. Genetic fundamentals in liver stone disease are of great importance because liver stones are not only found while operating upon the bile ducts or parts of the liver itself, but are also found at autopsy in people who have never been operated upon at all or who have died of some other disease.

Notwithstanding that isolated cases have been described in the literature of the sixteenth and seventeenth centuries, there is not as yet a completed statistical résumé of this condition, and surgeons with the most extensive material of gallbladder surgery at hand have reported only a few isolated cases. Even Beer's (1904) very extensive work cites only one or two case histories from the literature. Frerich, in 1861, presented five cases and von Thudicum (1863) and von Niemer (1891) published five cases of liver abscess in which stones were found. These are the only cases we have knowledge of which have been presented during the last century. Beer describes six instances occurring in his own series which, however, were found only at autopsy. Peters, Huhendorf and others have reported cases of liver stones which were also reported by Courvoisier, who collected 50 cases in 1891. We purposely do not cite reports from the latest foreign authorities in this paper. They are numerically and alphabetically arranged in an appended reference list.

Körte's monograph in 1905 and in 1928 presents only a few isolated cases

which are included in our appended statistical list. All the reports from the Russian literature date back into the twentieth century and deal with the description of a few isolated cases by Romanzew, Grasmik, Mattrossow, Calusow and Terebinskij, while the balance of the cases are of a more general character, their authors describing certain definite and specific phases of gallbladder and duct disease. These reports are by Walynzew, Hesse, Kadjan, and Fedorow (case taken from the work of Prof. Ikonnikow and Jukelson). My own work on this subject more fully completes these statistics by adding four more cases taken from the Clinic of Director Prof. Martynow, where I was an assistant, and another case which was placed at my disposal by Prof. S. P. Fedorow to be used in this work. These cases can be found in the "Brief Communications" from the service in the Annals of the Surgical Hospital and also in the *Kliniceskaja Medicina*, November 23 to 24, 1930 (Russia).

I was prompted to try to collect the following case reports as completely as I could, in order to ascertain the possibility of a preoperative diagnosis in hepatolithiasis; which type of applied method of treatment would be the most definitely satisfactory for the best end-result; the pathologico-anatomic picture; and finally, to clear up a number of questions of the pathogenicity of gallstone disease as a whole.

Our own cases consist of five in number. Forty-one are taken from the foreign literature and 16 cases are Russian. This report, I think, represents the most complete collection of cases, both foreign and Russian, on this subject. The only cases which will be detailed are the five of our own. The others will be referred to by number and the author's name only (references).

These figures do not by any means exhaust the existing material on the subject. Courvoisier's report, however, was not considered in our study because some of the cases were doubtful and not clearly described, their description resembling more the usual picture of gallbladder perforation with entrance of stone into the liver tissue, rather than that of liver stones. In other cases, the authors erroneously accepted hepatic duct stones as true liver stones. Furthermore, the surgery of the bile tracts in Courvoisier's report was not correctly designated by the authors, as no stones were found in the liver and no stones had ever actually been present. Although these authors may have been right, they concluded that the extrahepatic stones they did find originated in the liver.

Walijew critically evaluated gallbladder surgery in his work entitled "Liver Stones," the material for the treatise being taken from the Clinic of Professor Bogoras and reported at the First Congress on Surgery in North Caucasia, Rostow-Dow, 1926 (Russia).

Bykenhelm and Digby reported eight cases of liver stones found among the Chinese. Only three cases, however, were essentially liver stones, while the other five can only be accepted as of probable intrahepatic origin without any conclusive substantiatory evidence.

I have not detailed the cases reported by Erdmann, 1914. The report consisted of a critical review of 270 operations on the biliary tract with one

case of recurrence of stone after a cholecystectomy, which he classified as a true recurrence of stone from the intrahepatic ducts and cellular tissue. Cases of this kind are frequently seen. Kehr's statement that he has never seen a true recurrence of stone of intrahepatic origin may not be entirely correct but it is decidedly wrong to ascribe "overlooked," or "forgotten" stones as a true recurrence.

Italian and Spanish literature of the last year is not included in our statistics because the original articles were not at hand and the respective information came to us only from the yearly reports of cases (Finochietti, Lang, Hartinam, Weber and others). I also included a number of other cases, which, although not specifically described as liver stones, can, by their course and manifestations, be placed in this category (Eickhoff, Büdinger and others).

Individual authors (Calusow) dispute the rare occurrence of hepatolithiasis without conclusive grounds and principally only on the basis of logical and mathematical proof. Hepatolithiasis, according to data from Pathologic Institutes, is of rare occurrence; nevertheless, it can be accepted that a more careful examination of the liver in a number of these cases may have proved the exception.

We take the following from extensive statistics: Courvoisier, 1903. 16,025 autopsies—Found 1,714 cases of cholelithiasis in which there occurred one case of liver stone. Wolynzew, 1904. 945 autopsies—12 cases of cholelithiasis—two cases of liver stones. Hesse, 1911. 17,402 autopsies—278 cases of cholelithiasis and one case of liver stones. Miyake, 1913. 8,406 autopsies—257 cases of cholelithiasis—20 cases of liver stones.

In Japan, liver stones are relatively frequent. Miyake collected his material from three Pathologico-Anatomic laboratories. He found 191 cases of cholelithiasis in Tokyo, with 13 cases of liver stone; 35 cases in Kioto, with one, and 31 cases in Kinschu, with six instances of liver stones.

The veterinary literature reports only a small percentage of hepatolithiasis and cholelithiasis. Simonesco, 1901, found cholelithiasis seven times in 260 human autopsies; and in 3,000 autopsies on oxen he found cholelithiasis twice.

Case histories in the veterinarianian field show the striking rarity of this process in animals, and particularly in domesticated animals. Wild animals, such as deer and hares, rarely have cholelithiasis. It appears the anthropoid apes never have cholelithiasis. In the case of Dedjulin, a piece of wire, 3 cm. long, was found in the gallbladder. Sommermeyer states that he found dilated intrahepatic ducts filled with stones and intestinal contents in two cases of cholelithiasis in horses. These stones were essentially made up of bilirubin and calcium and contained cholesterol in lesser amounts. Frequently, foreign bodies such as corn, sand, fine nails, wire, *etc.*, have been found in the gallbladder.

In our 57 collected cases, 25 were operated upon as well as autopsied; 16 cases were interval operations without autopsy; and 16 cases came to autopsy without operation. In a number of instances, stones were only found incidentally at autopsy. A case reported by Hesse is in this category,

where the patient died of peritonitis following an operation for gastric carcinoma; also a case by Beer, where the patient died from sepsis; and finally, our own case (Case IV) where death followed a rib resection for empyema. The autopsy in this case showed stones in the liver and bile ducts. The last two cases of Fabre and Petrisso, 1932, did not come to our notice until after this work was ready for the press. The results in these two cases do not, however, alter our conclusions.

PATHOLOGIC ANATOMY.—The pathologic anatomy is most marked by essential changes in the liver. Schematically, these liver lesions can be divided into the following groups or stages:

Group 1.—Isolated lesions in portions of the liver with firmly fixed stones.

Group 2.—Circumscribed foci in the liver, with stones imbedded in a cavity containing bile, pus, or a (greasy) pultaceous mass of thickened bile.

Group 3.—Presents a more extensive process and the liver stones are co-existent with extrahepatic duct involvement, while the intrahepatic ducts contain a pultaceous (greasy) substance with occasional occurrence of stones of the same material, or of different structure and consistency than that of the stones in the extrahepatic ducts.

Group 4.—The same picture as in Group 3, except that the small biliary channels present the character of a purulent cholangitis and in some cases the liver will be studded with foci of small abscesses containing stones either fully formed, or of a cement-like, or pasty, consistency.

The third group, in some cases, as in the fourth, is quite frequently accompanied by marked and severe changes in the cardiovascular system, the kidneys and the liver, leading to complete cessation of function of these organs. In some instances, it appears as though one of the groups was a prodromal stage to the next group, with manifestations of extensive pathologic changes; gradual, quantitative and qualitative increase of the process involving the greater part of liver parenchyma and liver cells and showing evidence of early sedimentation, for later stone formation, in the most minute intrahepatic ducts by a definite inflammatory process. The liver appears normal. This macroscopic appearance, however, frequently differs from the palpatory as well as the microscopic findings (Fig. 1).

The marked, existing pancreatitis sometimes, when the liver appears normal at the operation, concentrates one's entire attention on the pancreas. At autopsy, however, immediately following the operation, deep seated and long standing changes in the entire liver parenchyma, with the coexistence of many well formed stones, will be found. At times the liver will be found normal at autopsy in the presence of marked cholangitis and also a large number of stones in the bile ducts where the presence of a normal liver should naturally be excluded. External appearance of the liver does not exclude liver pathology. Microscopic examination should be done in every case to clear all doubt (Figs. 2 and 3). In the majority of cases the liver is enlarged. Its color is dark blue (Calusow), with indurated edges at times or definite anemic foci (Büdinger), icteric (Haberer), markedly hyperemic



FIG. 1.—Macroscopically changed liver tissue (somewhat enlarged), occurring in the first case we operated on. This portion of the liver was removed, containing stones in chain, or tandem formation. There is a clear picture of proliferation of Glisson's capsule and signs of liver jaundice due to stasis.

(Kehr, Büdinger and others) and, more rarely, its appearance is soft and flabby (Rufanov) or sometimes it appears in the form of a constricted liver, corset liver (Oehler).

Enlargement of the liver is twofold in character; either a general uniform enlargement, or irregular enlargement of only one lobe, as seen in our first case where the liver was not of conventional form and the right lobe extended to and into the pelvis, the left lobe presenting an unusual incisure and a small accessory lobe measuring 3 by 3 cm., which was suspended from its under surface; this half of the liver was particularly subjected to pathologic changes. Oehler also speaks of such increase in the size of the liver, especially of its inferior surface. This enlargement is sometimes caused by a preexisting cavity filled with pus, bile and stones. It is usually either a cyst, a pus pocket or a carcinomatosly indurated area and with any one of these three diagnoses the patient is usually operated upon. The indurated nodules in the liver may reach the size of a hen's egg (Naguchi), or the liver may have spots of whitish plaques or scar tissue which, upon incision, display either a stone or a cavity. These cavities at times besides containing stones may also contain pus and bile, or either alone (most frequently altered bile) and the stones are then found imbedded in the wall of the cavity. At times the tensely dilated ducts, filled with stones, branch out from the liver cavity.

The wall of the cavity is rarely thin or easy to open like a cyst or an abscess depending upon its relation to the surface of the liver and its location. Most frequently, its wall is firm and compact and removal of all the stones is only fully accomplished by resecting portions of the liver parenchyma itself. It is sometimes formed by dilated intrahepatic ducts, or, in some cases, may consist of scar tissue only.

Macroscopic liver changes, in the form of obliterated, regenerated areas, may, in some cases, be recognized as soon as the liver is incised. Liver changes usually coexistent with cholecystitis are microscopically present only when the case is marked and advanced. One will find conditions of liver stasis, hyperemia, biliary cirrhosis, foci of round cell infiltration, sometimes abscesses (recognized microscopically only), scars, atrophy of the parenchymatous cells, necrosis and regenerated foci of newly formed tissue. The cells themselves contain a branch-like distribution of pigment. Intrahepatic ducts are dilated in most cases, containing pigment and sometimes a proliferation of liver connective tissue itself around the bile ducts or, in other words, the picture of pericholangitis is found and seen (Eickhoff). Sometimes the smallest and most minute branches of the bile ducts are filled with a doughy mass, or filled with very small, yet formed calculi, presenting the picture of a lithiac cholangitis.

The pathologico-anatomic picture of the liver is the result of complications arising from recurring or perforating cholecystitis with changes in its surrounding tissue, or is at times found where there has been an extension of the process to neighboring and adjacent organs and tissues. Hydrops of the gallbladder was never seen.

Very marked changes in the gallbladder wall were sometimes coexistent with the absence of gallstones in the gallbladder itself. The microscopic picture of the gallbladder also corresponds to the same changes one finds in cholelithiasis.

Bile.—There is usually only a small amount of turbid bile found in the gallbladder because of either the presence of a stone, cholangitis, or an atrophic and shrunken gallbladder (Büdinger, Rufanov and others), or the bile is of a mucoid (Kadjan), mucopurulent (Beer and others) or purulent character (Beer and others).

Cases of perforation of the gallbladder into the liver have been observed. The bile, not infrequently, contains clumps of bile pigment or cholesterol and sometimes its content is made up of a glycerinated (Bykenelow), clay colored, lardaceous mass, in which bile pigment is held suspended (Körte) yet sometimes this mass is grayish-white or green and cholesterin-like in color (Büdinger). Sometimes, shortly after operation there occurs only a slight amount of bile drainage and bile secretion which shortly disappears completely. In some cases only white bile was found. The quantity of bile in the bile ducts was mostly found to be small, but in a few cases we found that the liver capillaries contained a great deal of bile; on the whole, and most frequently, however, there appeared to be a deficient liver function and a lowered bile secretion.

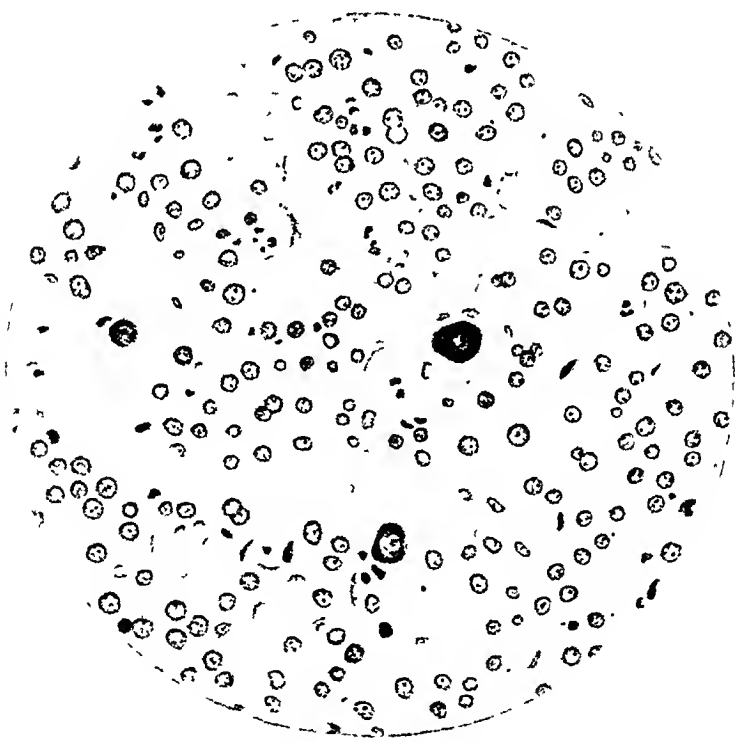
The bacteria found in the bile belong to the same group found in cholelithiasis, such as *B. coli* (Vachel and others), coli-like bacilli (Naguchi), spores (Matrossow), *Staphylococcus* (Matrossow), *B. pyocyaneus* (Kadjan), *Streptococcus viridans* (Eickhoff). The bile was not examined bacteriologically in all cases.

Neighboring organs and tissue are frequently involved in the process in the form of adhesions ranging from mild perivisceral to firm and formed adherent scar convolutions. The predominating adhesions involve the stomach and subsequent adhesive scars may sometimes lead to permanent pyloric stenosis demanding gastro-enterostomy. In two cases a gastric ulcer was found at autopsy.

Intestinal adhesions sometimes form an adherent mass analogous to that seen in circumscribed purulent peritonitis, from which the clinical manifestations of a complete intestinal obstruction occur, indicating the necessity of performing an enterostomy.

Obstruction in the liver sometimes causes sufficient kinking of the intrahepatic ducts to predispose to bile stasis and the formation of stone above this obstruction (Teribinskij). Edema or scar tissue of the hepaticoduodenal ligament has been observed (Fedorow), the scar formation favoring disturbance in the portal vein circulation and stasis, hemorrhage, or ascites (Kehr and Eickhoff). Sometimes the smallest bile ducts and passages are found dilated, forming rather large cavities with a glossy inner surface containing pigment, mucus, stones and white bile.

Cases of neoplasm in the bile ducts have been seen. Granular, brownish-



Figs. 2 and 3.—The biliary capillaries contain compact stones which have a somewhat dark center and a lighter periphery. In some of the biliary capillaries, there is evidence of stasis. Atypical liver lobuli not definitely encircled. In parts of the liver, the central veins are absent and there is a characteristic, atypical, cirrhotic picture. In the liver cells themselves, one sees dilated canals.

black, pigmentary deposits are mostly met with in the presence of a parenchymatous, necrotic or necrobiotic area and are due to excretion of pigment from the liver cells. The intrahepatic ducts on the liver surface were sometimes dilated to an enormous size, in some instances to the diameter of a goosequill, and immediately upon incision of the liver there ensued a flow of bile. As we mentioned before, the stone-containing bile ducts present the appearance of a firm and fixed chain of stones.

Bile Ducts and Gallbladder.—Marked anatomic changes are present, mostly involving the extrahepatic ducts. Macroscopically, they are rarely found normal. These ducts, as well as the intrahepatic ducts, are mostly dilated to large circumferential dimensions. The cystic duct may contain valves and diverticula (Oehler) in which stones of such large size (in Oehler's case, the size of a pigeon's egg) may be found, so imbedded that they can be removed only with great difficulty. The cystic duct may also be tensely filled with a compact mass of stones, or, as in the case of Kadjan and others, stones may be present in the liver and the cystic duct found completely occluded, indurated, distended, or in some cases, pulled over to the stomach by contracting scar tissue. The common and hepatic ducts, due to obstructive tissue changes, may develop stasis on the one hand and duct dilatation on the other; the sequence of infection and the presence of stones.

Dilatation of the bile passages reaches large dimensions, even to the size of the circumference of the small intestine (Jukelson). The walls of the biliary passages, due to their distention, *etc.*, as mentioned above, lose their elasticity, become thickened, infiltrated and sometimes (Körte) ulcerated or encrusted. Less frequently we find scar tissue changes, such as stricture of the common and hepatic ducts. In a number of cases the gallbladder remains normal or sometimes it is found flaccid or distended. In the majority of cases, however, marked anatomic changes are present. In 40 per cent of cases, evidence of acute, purulent or ulcerating cholecystitis or an empyema of the gallbladder is present; 20 per cent show either an atrophied, shrunken, or indurated wall and sclerosis of the gallbladder and finally, in 20 per cent, the gallbladder will be cicatrized and occluded, the occlusion sometimes being confined only to its mucous membrane as in the case of Eickhoff, or involving its entire wall. Pericholecystitis is, not infrequently, observed.

In secondary involvement of other organs we find, first, changes in the pancreas in the form of a chronic, secondary, indurative pancreatitis (swelling of the head). The percentage of chronic pancreatitis in this condition seems to be less, however, than we usually find in cholelithiasis. Acute pancreatitis was not present in any of our cases. Secondly, there may be a right-sided pleural involvement in the form of a serous or purulent exudate (pleuritis), as a complication during the course of this process.

Finally, the kidney may be damaged (Rufanov). The urine may contain albumin, leukocytes, erythrocytes and kidney epithelium. Cases of kidney cirrhosis with nephrosis and nephritis with edema and anuria, as well as uremia, have been described. We did not find any instances of acute peri-

tonitis in any form. Eickoff found a chronic progressive peritonitis in his case. In a number of instances the alvine inflammatory reaction confined itself to a localized, purulent peritonitis.

Stones.—The number, character, size and shape, as well as the chemical structure of the stones occur in a great, diversified multiplicity. The occurrence of stones in the liver and in the various portions of the extrahepatic passages is shown in Table I.

TABLE I
STONES COEXISTENT IN LIVER AND EXTRAHEPATIC DUCTS

Gallbladder	Cystic Duct	Hepatic Duct	In Liver	Cases
1. Gallbladder	Cystic duct	Yes	In liver	19
2. Gallbladder	Cystic duct	None found	In liver	5
3. Gallbladder	None found	None found	In liver	2
4. Gallbladder	None found	None found	In liver	4
5. None found	None found	None found	In liver	6
6. None found	None found	None found	In liver	6
7. None found	None found	None found	In liver	11
				<u>Total 53</u>

It will be seen from this table that in 20 per cent of cases there were stones in the liver and none in the gallbladder and bile passages. In 80 per cent of cases there were stones in the gallbladder or biliary passages, or in both at the same time, as well as in the liver. In 35 per cent of cases there were stones in the gallbladder, bile passages and liver at the same time, and in 60 per cent the gallbladder had stones, whereas in 40 per cent there were none present. These figures, in the study of the clinical course of the process and operative result, are of great importance, as will be seen later.

The number of stones varied from one to 1,000 or more. The presence of minute and very small stones caused thought that their numerical assessment was impossible, or that the liver was completely filled with them. Removal of a number of stones at operation did not prove that all the stones had been removed, because frequently at a second operation more stones were found and removed, or they were expelled after the operation, through the drains. There are two cases recorded, where 12, 20, 36 and 52 stones were found.

In our third case, upon incising the liver, stones projected from all the smaller and larger biliary ducts. In the case of Vachel and M. Stewens, there were 520 stones found in the deformed part of the liver, one of which, weighing 270 Gm., lay in a cavity with other small stones. In this case, the hepatic and common duct contained up to 5,100 stones, of which the largest weighed 100 Gm. The total weight of all the stones was 1,378 Gm.

In most cases, however, we find small stones with gravel, ranging in size from cherrystone or pea size, and measuring from a few millimeters to 1 cm. in diameter, in the form of a pultaceous-like, sebaceous mass. In some cases, the stones are as large as a hen's egg and of two of these stones removed from a liver scar one was 2.7 cm. and the other was 3.2 cm. in diameter.

In a number of cases (Federow and others), all intrahepatic passages, as

well as the extrahepatic bile ducts and biliary passages, were tensely distended by a pulaceous, unguentous mass.

The color of the stones varies according to the amount of their pigment content, from a grayish-white (Hawks; Matrossow), yellowish-white (Büdinger); yellow (Rufanov); yellowish-green (Büdinger); gray (Matrossow); dark red (Beer, Rufanov, Kocher); brown (Büdinger); brownish-black (Rufanov) and black (Beer, Calusow). At times we find light, as well as dark stones, in the same case.

The shape of the stones is most frequently round, sometimes club-shaped (Körte); dome-formed, ovoid (Beer); multicorned, (Sieber); polyhedral (Rufanov); tetrahedral; and they may be only partly (Beer) or entirely faceted (Sendler, Romanzew). Furthermore, cylindroid stones have been found, as well as arborescent forms, representing the smallest bile passages (Terebinskij, Barth and others).

The stones may be soft and easily pulverized, yet sometimes, as in the case of Büdinger, the soft, powder-like stones began hardening 24 hours after removal, and at the end of three to four days had taken on the character of firm calculi.

The Chemical Consistency of the Stones.—Stones occur in various combinations of their main constituents as bilirubin or cholesterol, or they occur as pure cholesterol or bilirubin stones. Cholesterol stones were found in the cases of Sieber, Büdinger, Lewison (48 cholesterol stones), Judd, Burden and others. Pigment and pigmented cholesterol stones (Beer and others) are also met with. In our case, there was a calcium combination with bile pigment, bilirubin and cholesterol, with calcium and magnesium salts. Terebinskij found the same combination, with the exception of magnesium, in his case. Beer's case of extrahepatic stones contained an encrusted pigment mass around a cholesterol center. The intrahepatic stones, on the other hand, were devoid of the cholesterol center, being made up of pigment and calcium.

In Kadjan's case, all the ten stones contained 68 to 76 per cent cholesterol and 17 to 24 per cent calcinated bilirubin. One stone in the common duct contained a center with a high cholesterol content. In Matrossow's case, the single, round, gray stone consisted of a carbonate phosphate of cholesterol and pigment. In Büdinger's case, the stones were made up of cholesterol and a small amount of calcium and bilirubin. The large stone in Vachel's case, which weighed 270 Gm. and which was one of 250 other stones, contained 18 per cent cholesterol, 39 per cent calcinated pigment, and 0.01 per cent iron.

In Oehler's case there were two kinds of stones: (a) small, faceted, cholesterol stones containing bile pigment, and (b) large firm stones of which two were 4 by 2 cm. and 5 by 2 cm. in size. The large stone contained a nucleus of cholesterol and pigmented calcium. Two others, however, contained no center. Romanzew found 30 faceted stones, in size from gravel to

a cherry-pit, with large, pigmented centers, surrounded by a radiating cholesterol layer.

ETIOLOGY AND PATHOGENESIS: The question of cause and formal genesis of hepatolithiasis and cholelithiasis are the same. It revolves around hypothetical reasoning and practical interest. The primary cause, whether arising from partial (gallbladder), or complete (liver); from local or general conditions of the organism; from stasis; from infection; diathesis or disturbed organic metabolism, has not as yet been solved.

Does stasis arise from anatomic conditions or anomalies (Berg); or is its occurrence due to functional disturbances (Westphal)? If the clinical history discloses infection, is this the immediate cause of the inflammatory process in the bile passages and the subsequent liver tissue destruction? Is the liver damage, primary or secondary to a metabolic disturbance (hypercholesteremia) which produces toxic changes and disturbs the normal quantitative and qualitative secretion of bile?

Mindful of the fact that every third person after 70 is a gallstone carrier, the question is raised of whether arteriosclerosis affects the vessel wall and brings about changes in the contracting force of the excretory ducts and disturbs the nutrition of the liver cells thereby acting as a primary cause. On the other hand, is the arteriosclerosis and subsequent stone formation only the result of a disturbed cholesterol or metabolic dysfunction?

Is the frequency of lithiasis in the female due to tight lacing; corsets, or other mechanical means of pressure, or is it due to an unstable and predilectively susceptible nervous system increased by the rising and falling curve of cholesteremia which concomitantly changes with and from the beginning of puberty; during every menstruation and every pregnancy during the sex life of every woman? How does the vegetative nervous system act on liver metabolism? Is it solely through secondary, stimulative, sensory, motor and secretory nerve cell and fiber disturbances which convey abnormal impulses not only to the functioning liver apparatus and ducts but also to other organs? Or conversely, can lithiasis be ascribed to lesions and stimulation in the central or the local nervous system (solar plexus) causing colloidal changes, changes in mineral metabolism and in the permeability of the cell membrane itself, thereby establishing a primary cause for stone development?

These are the essential controversial points we find in the present literature, around which the genesis of lithiasis is centered. As has been previously stated, stones are frequently found in people of advanced years.

Literature frequently refers to the presence of gallstones as of theoretical interest only. When infection or occlusion of the excretory ducts occur, however, they assume practical importance because of the serious and sometimes threatening clinical picture of cholelithiasis. If, on the other hand, in cases of latent cholelithiasis, treatment is instituted before the inflammatory process has developed, this practical interest cannot be considered.

When active and definite formation of calculi begins is not known, and

it is impossible to establish or ascertain when the initial clinical symptoms first began. Not infrequently the clinician accepts a functional liver syndrome or one coming from the bile ducts, *i.e.*, the sphincter of Oddi, or accompanying manifestations coming from other organs, stomach, intestines, pancreas, etc., with or without organic disease, as lithiasis. Actually, however, we frequently cannot determine the syndromic termination of the physiologic pathology and the clinical onset of the pathologic anatomy. A preexisting mild infection, an occlusion of the ducts, or an additional infection may be sufficient to kindle or stir up a definite clinical picture after the previous course of a portentous process. The very fact that a stone is present demonstrates marked metabolic disturbance which may be still further activated by the stone itself.

The presence of stone can be accepted as a stage only, and not a separate group, of manifestations in gallstone disease. The clinician should not allow himself to become interested. It represents the same stage in the clinical exhibition of gallstone disease as that of the stage of grease and gravel as the forerunner to the formed gallstones.

It is not my intention to summarize the theories on formation of stone. They have been fully elucidated by Lütken, Fedorow, Finkelstein and Bereskin. The latter has critically evaluated the theories and observations of the foreign and Russian literature, Aschoff, Naunyn, Chauffard, Rovsing; their predecessors and schools have by a series of intense studies of factors substantiated one or another of these theories. The theories of infection, stasis and disturbed metabolism, as of principal etiologic importance, constantly vary for and against their evaluation and acceptance. Each theory is of preeminently primary or essential etiologic moment, and is upheld by a series of valuable clinical and experimental observations. Each of these conditions may occur in certain people, probably in each patient at a certain age, from a congenital, acquired, anatomic or functional anomaly of the liver and biliary ducts and a subsequent stasis.

Infection and disturbed metabolism may be present, however, without the actual formation of stones. Sometimes an attack of lithiasis occurs without any apparent etiologic factor. In these cases, conditions which predispose to stasis and infection should be looked for in the anamnesis.

For 50 years, disturbed metabolism was considered the main etiologic factor in lithiasis. Today this theory has been replaced by accepting stasis and infection, the latter playing the leading rôle, as the main cause in this condition. Fedorow and others defend Chauffard's theory. It is hard to conceive or visualize the entire course and process of stone formation beginning and active only in the bile ducts and gallbladder, to the considerative exclusion of the liver, the vegetative nervous system; the metabolism and all conditions which influence the quantitative and qualitative characteristics of the bile before it reaches the gallbladder, and finally not to forget to include the various degrees of colloidal change and permeability of the liver cells.

We divide our material of hepatolithiasis into two groups: (1) those complicated with cholecystitis and cholelithiasis; (2) those without any complication of the gallbladder. We found a differing clinical course and a different result of the surgical technic in one and the other group. Complicated extrahepatic duct lithiasis with hepatolithiasis considered by its course, as well as the result of its therapeutic and surgical treatment, is a more severe illness than that of hepatolithiasis occurring alone.

Leopold presents a case of liver stones in the absence of a gallbladder, thus establishing the possibility of the formation of stones in the liver when the gallbladder is absent. In a case of removal of a large stone from the common duct, in the congenital absence of a gallbladder, Finkelstein reported the recurrence of a stone the size of a pigeon egg which he removed. This stone, without doubt, came from the liver. In Terebinskij's case, the center of a gallbladder stone was made up of products of duct effusion. These facts led us to conclude that liver stones possibly do form without any gallbladder pathology.

In our third group of cases of liver stones, the extrahepatic ducts were completely intact. Stasis in this type of case can, therefore, play no part in etiology and infection can hardly be looked upon as a primary cause. If the infection were virulent or purulent, cholangitis would follow, and a mild infection would not only involve the extrahepatic ducts, but the liver as well. More likely, the primary condition in these cases is due to disturbed metabolism.

Other concomitant conditions may exist, however, but they cannot be classed as a primary cause. In this conclusion, I omit any consideration of hunger, fever, *etc.*, relative to their influence to bile secretion, stasis or the qualitative character of the bile (Experiments of Wilishanin, Michailow, Lukjanow). Russian authors have shown that hunger, fever, uremia and kidney lesions decrease the secretion of bile. Lukjanow presents the observations of Uffelmann, in the case of a woman with a cholecystenteric fistula, who showed marked cessation of bile secretion during an intercurrent attack of pneumonia.

It is a physiologic fact that pain itself will reflexly check liver activity. Siebert and Castaing (1899) state that gallbladder colic acts reflexly on the liver, causing cessation of its function (analogous to an anuria during kidney stone colic) with the appearance of sugar and urobilinogen in the urine. In these cases, we can also observe qualitative changes of the bile and deposits of its solids due to changes in the alkaline medium, besides the condition of stasis. It is known that acid bile precipitates bilirubin (Thudicum). Infection, as well as a number of other conditions (metals, *etc.*) can alter the reaction of the bile. The findings of Ikonnikow and others have substantiated pigmentary deposition outside of the gallbladder. Every damage to liver parenchyma, as well as change in its vascular supply, influences the permeability of the liver cells. The complicated innervatory relation to the various sections of the extrahepatic ducts should be recognized as particu-

larly important because of the active duct contraction it induces. Westphal has confirmed the clinical significance of these dyskinesias as a cause of biliary colic and resultant lithiasis.

Excitation of change in the regulatory bile secretion apparatus during menstruation is the example of endocrine influence. Molinar, basing his opinion on observation in 365 of his own cases, believes that constant or temporary cessation of genital gland activity is one of the most frequent causes of gallstone disease.

Cases of lithiasis with a psychoneurotic background are well known, and conversely, there is no doubt that the secretory function of the liver is greatly influenced by psychic conditions as is manifested in cases of emotional jaundice.

Stuber remarks that the stimulation may arise from humeral influence (hormone or toxins) or may originate from some portion of the autonomous nervous system, the vegetative or the highest cortical centers. The result of this excitation or stimulation of the organ itself, especially in women with a high lability of their vegetative nervous system, is essentially manifested where there is the greatest amount of nerve supply, namely, the sphincter of Oddi and Lutken. Stasis, obviously, will follow motor disturbance.

Where heretofore possible stasis followed by the deposition of concretions due to changes in physical, chemical and colloidal characteristics of the bile was accepted as a conjectural probability, today this question appears to be definitely solved.

Change in the innervation of the liver can lead to stone formation. In this respect, the experiments of Doctor Gaisinsky in the laboratory of Professor Alperin are of great interest. He concluded that visceral innervating disturbance of the liver essentially through the sympathetic alters the 24 hour cholesterol balance in the organ notwithstanding what the blood content is. Due to this action of the sympathetic, the cholesterol permeability in the liver is changed, owing to disturbance of cholesterol metabolism, or probably due to changes in the permeability of the liver cells themselves.

Conditions which produce this variation in the 24 hour cholesterol balance bespeak alteration for liver permeability without, however, disturbing the periodic 24 hour quantity of the bile and cholesterol content from its normal level. By modification of innervating influences to the liver, changes in the permeability of its membrane for colloidal cholesterol were produced by abnormal influence of the sympathetic on the hepatic artery and complete section of the hepatoduodenal ligament. Gaisinsky observed the formation of pigment and mineral deposition in the bile: agreeing with Rovsing as to the genesis of lithiasis. These pigment deposits can predispose to stone formation. Alperin by his experiments emphasizes the importance of the sympathetic nervous system in changing the physicochemical character of the bile. Liek lays great stress on the nervous system. He points to a number of motor and secretory disturbances such as spasm, hypertonia,

copious cholesterol and mucous secretion, delayed absorption, similar to the type seen in membranous colitis or in bronchial asthma. Gastric sub- or anacidity are in close relation to a neurogenic influence in three-fourths of the patients whose gastric peristalsis was studied during gallstone attacks.

Stasis in the liver may be caused and the origin of liver and gallbladder stone may arise following change in liver function, change in the reaction of the bile itself, change in the colloidal portion of the excretion, as well as alteration in the permeable qualities of the liver cell membrane.

Rovsing's theory of the cause of liver stones, is confirmed by a large number of cases. The contention of Minkler, Tietze, Körte, Finkelstein, Rufanov and others, that although the parenchyma of the liver exhibits changes in the presence of extrahepatic duct infection and cholelithiasis, the liver pathology is not, as we will see later, caused by an ascending infection from the gallbladder to the bile and smallest ducts, and thus into the liver, but is more likely to occur from primary changes in the liver itself, producing conditions favorable to stasis and subsequent lithiasis. Disturbance in metabolism primarily brings about a change of function in the liver and not in the bile ducts which confirms this contention. This, however, does not exclude the possibility of an ascending infection, an angiocholitis or a liver abscess, the onset of which may be hastened by stasis or decreased secretion of the liver cells.

The evaluation of our material offers interesting conclusions. Thirty-three per cent died of cholangitis (7 in 21); 66 per cent of liver insufficiency (14 in 21); liver damage in its relation to bile duct pathology was in the majority. We failed to find any basis for the statement that under all conditions stone formation begins only in the gallbladder. The same conditions and the same factors may exist in the smallest, as well as the largest, bile ducts (Hein, 1846, as cited from Romanzew). To say that the primary predisposing factor for stone formation is the presence of a cavity where stasis or infection may more easily occur or enter is analogous to excluding the parenchyma of the kidney as the most important site in the formation of kidney stones. Many cases of pyelitis exist for years without the formation of calculi. The same contention holds good in the stagnant urine in the presence of a large prostate where even, with a large bladder cavity, stasis and infection do not cause formation of stone. It is also a pertinent question in cases of hydrops of the gallbladder. In these cases, the history is sometimes negative relative to a report of any attacks of gallbladder colic; in some cases only a dull pain or a very slight attack of colic has occurred, although the stone has advanced into the neck of the gallbladder, causing the hydrops by obstruction.

It seems that with a normal gallbladder wall with active contractibility, any closure of the cystic duct by a stone should manifest more clinically pronounced symptoms than are usually observed. The wall of the gallbladder is frequently only slightly atrophic, from the distention of the

hydrops, yet, however, there is a concomitant coexisting marked liver change. Whereas we accept the usual explanation of mechanical closure of the cystic duct, we can hardly refute the contention of another cause, such as the entrance of a stone into the gallbladder, which originated in the liver, gradually increasing in size in the neck of the gallbladder, with a consequent gradual distention of this viscus which retains relatively good contractibility of its walls. Kulenkampf (1926) is probably right when he says that it is impossible for a stone to travel from the gallbladder into the ducts considering the structure of Heisters' folds.

In 1930, I stated that the climatic and living conditions of various peoples in their relation to the marked difference in the frequency of incidence of liver cirrhosis and gallstones, especially in the formation of variously chemically constituted stones, such as pigment and cholesterol, should not be ignored. At the last Pathologico-Anatomic Congress, Askanasi, discussing liver cirrhosis in relation to the macro- and microlithic interest, called attention to the contentions previously put forth by Hoppe Seiler (1866), Klebs (1869) and others, of the presence of copper in the pigment stones. The large amount of copper found in the livers of people living in Geneva caused the author to reopen this question of the cause of this condition. Askanasi, furthermore, brings up the question as to whether this metal does not play the rôle of a catalyzer in the oxidation process, which function, according to Naunyn, accompanies infection.

Askanasi, in relation to macro- and microliths and the liver cirrhosis, shows that in 21 cases of liver cirrhosis he found microliths 15 times and pigment stones three times. Lammel, however, in 1927, found microliths 21 times in 62 cases of cirrhosis and pigment stones nine times. In searching for the cause of the numerous instances of cirrhosis occurring in Geneva and Japan, the author contends that this is possibly explained (as compared to other countries) by the large copper and iron deposits in these countries. Mallory, in 1925, has experimentally substantiated the clinical observations of the author.

Referring to the reciprocal relationship between the liver and spleen, we also see a parallel between liver changes and stone formation, although it is a different pathologic consideration. This relationship is not without importance. Moynihan, in one of his cases quoted by Finkelstein, after six operations on the gallbladder and gallducts, during which time he removed several thousand stones, drained the ducts and, finally, removed the spleen before he obtained a cure. Another similar case is reported by Bernhard and Malet-Guy (Klarel, Lyon, Surgery, 1928). A gallbladder fistula was produced because of pigment stones in the gallbladder. The formation of the pigment stones was coexistent with a hemolytic icterus. Due to the continued icterus, the spleen was removed following which the patient rapidly recovered.

This confirms acceptance that stones in the gallbladder and ducts may sometimes arise from causes exogenous to the gallbladder and the liver,

as substantiated by cited cases; the cells of the latter being unable to take care of, or react to, the increased demands made upon them, the spleen reacting to the increased breaking up of hemoglobin and iron deposition with consequent formation of true pigment stones.

All these facts concerning the possible method of the intrahepatic origin of stones, the liver changes in extrahepatic gallstones, microliths and their relation to metabolism and the rôle of the spleen and its functional products toward the formation of liver stones, belong to the consideration of the genesis and the etiology of gallstones. It is not to be forgotten, however, that the liver can also react to a large number of damaging factors, *i.e.*, endocrine in character (Molnar, 1926), disturbance of its metabolism, diseases of the blood, and other influences which in one way or another cause stone formation by connective tissue proliferation.

(To be continued)

CONGENITALLY SHORTENED ESOPHAGUS (THORACIC STOMACH)

REPORT OF TWO CASES FOUND POSTMORTEM

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A NUMBER of malformations of the diaphragm associated with abnormalities of the esophagus and malpositions of the stomach has been reported in the literature; but only in a very limited number of such cases has it been possible to examine the organs postmortem and determine the exact relations of the parts. The cases here presented offered such an opportunity; and, because of the clinical importance of any facts which might lead to a better understanding of the origin and significance of these disturbances, it is felt that the following detailed description of the anatomic structures is justified.

Two cases were found during 1934 and 1935 among the dissecting room specimens in the University of Texas Anatomical Laboratory.

CASE REPORTS

CASE I.—The subject was that of a Mexican female, F. A., aged 60 years. The death certificate gave bronchopneumonia as the cause of death; beyond this fact no clinical history was obtainable.

No external indication of any abnormality was apparent except a fair degree of scoliosis, convex to the right in the lower thoracic region with an associated compensatory curve in the lumbar region. The body was short, stocky, and quite obese—the latter condition indicating that the alimentary tract had functioned satisfactorily.

From the thoracic aspect, it was noted that there had been displacement of a heart of normal size to the right. Measurements showed that it extended 5.5 cm. to the right of the midsternal line at the level of the fourth costal cartilage and only 4 cm. to the left at the level of the fifth interspace.

When the lungs were removed, a soft tumor mass beneath the mediastinal pleura could be seen in the posterior mediastinum. The tumor measured 7 cm. by 10 cm., and the wall of the sac over this mass was wrinkled and appeared as if it had been distended even to larger dimensions during life (Fig. 1).

When the sac surrounding the mass was incised vertically along its midventral line, it was seen to be lined with a glistening serous membrane which proved to be continuous with the peritoneum below. The contents, consisting of the stomach and the major portions of the greater and lesser omenta, were not fixed at any point to the wall of the sac, except near the middorsal and midventral lines where the serous membrane lining the wall of the sac reflected on to the stomach (Fig. 2). This reflection near the midventral line was a part of the lesser omentum. A finger was placed against the left side of the stomach and carried downward through a constriction at the diaphragm into the great peritoneal sac.

An incision was then made through the lesser omentum, and the cavity to the right of and behind the lesser omentum was explored. A finger was passed dorsally and met another reflection from the wall to the contents. By placing a finger on either side of this dorsal reflection, it was possible to observe that the two layers were adjacent, short, and held the stomach closely against the dorsal wall, except for a short distance along the body

of the stomach. This lower portion of the body of the stomach had apparently undergone partial rotation on a vertical axis. It was only in this limited extent that abnormal greater and lesser curvatures could be identified. Below the body of the stomach, the pyloric portion was bound closely to the dorsal body wall. A finger was then carried downward behind the lesser omentum along the right side of the stomach and pushed through the constriction of the diaphragm into the cavity of the omental bursa. Hence, it was apparent that both the great peritoneal sac and the omental bursa were carried upward surrounding the high placed stomach. Above, at about the level of the lower end of the esophagus, the serous membrane which lined the sac was reflected on to the contents.



FIG. 1. (Case I.)—Shows tumor mass in the posterior mediastinum.



FIG. 2. (Case I.)—Shows part of contents of sac. Note the dorsal reflection from the wall of the sac on to the stomach.

Dissection of the wall of the sac showed that it consisted of two layers of tissue (Fig. 3). The outer layer was fibrous in character. It was adherent all around with the subjacent layer; but a definite separation could be made easily. This outer layer thinned out as it ascended to the esophagus and spent itself by forming a delicate fibrous sleeve about the lower end of this organ. Inferiorly, the layer became thicker, contained occasional muscle fibers, and lower down became continuous with the tissue of the diaphragm. The second layer or lining was a serous membrane, the peritoneum; and the reflections and connections of this layer in the sac have already been pointed out.

Further dissection revealed an esophagus flattened from before backward and wider than normal, the width varying from 2.5 cm. to 3 cm. There was no evidence of stricture. The esophagus took a straight course vertically downward. After coursing a distance of about 1 cm. within the sac, the esophagus ended at the level of the third costal cartilage by terminating in the high placed stomach. With reference to the vertebral column, the esophagus ended at the level of the lower border of the body of the sixth thoracic vertebra. That the esophagogastric junction was at this level was verified by microscopic examination of the mucous membrane.

The vagus nerves united on the esophagus to form a definite plexus (Fig. 3). The

plexus began at the level of the upper extent of the lung roots and extended downward to the point at which the esophagus entered the sac. The right continuation of the plexus placed it posteriorly on the esophagus; and some branches, after penetrating the wall of the sac, reached the stomach along the right side and passed ventrally on the organ (Fig. 3). However, most of the branches continued inferiorly between the two layers of the wall of the sac, passed below the main part of the diaphragm, and terminated in the celiac plexus. The left continuation of the plexus passed downward without branching for 2.5 cm. superficial to the sac on its lateral aspect. Branches were then given off which took one of two directions: a few branches took a recurrent course upward toward the esophagus and then turned downward along the left side of the stomach; but most of

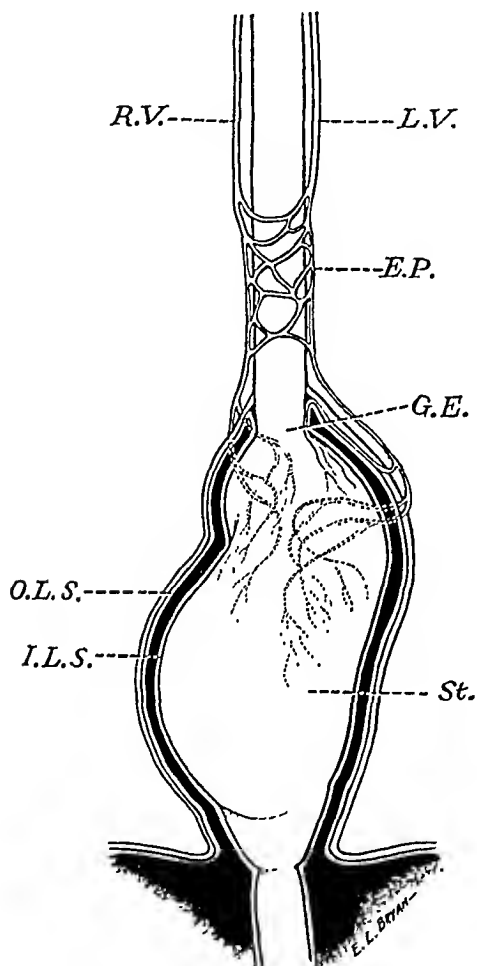


FIG. 3. (Case I.)—Diagram showing wall of sac and arrangement of vagus nerves. *R.V.*, right vagus; *L.V.*, left vagus; *E.P.*, esophageal plexus; *G.E.*, esophagogastric junction; *St.*, stomach; *O.L.S.*, outer layer sac; *I.L.S.*, inner layer sac.

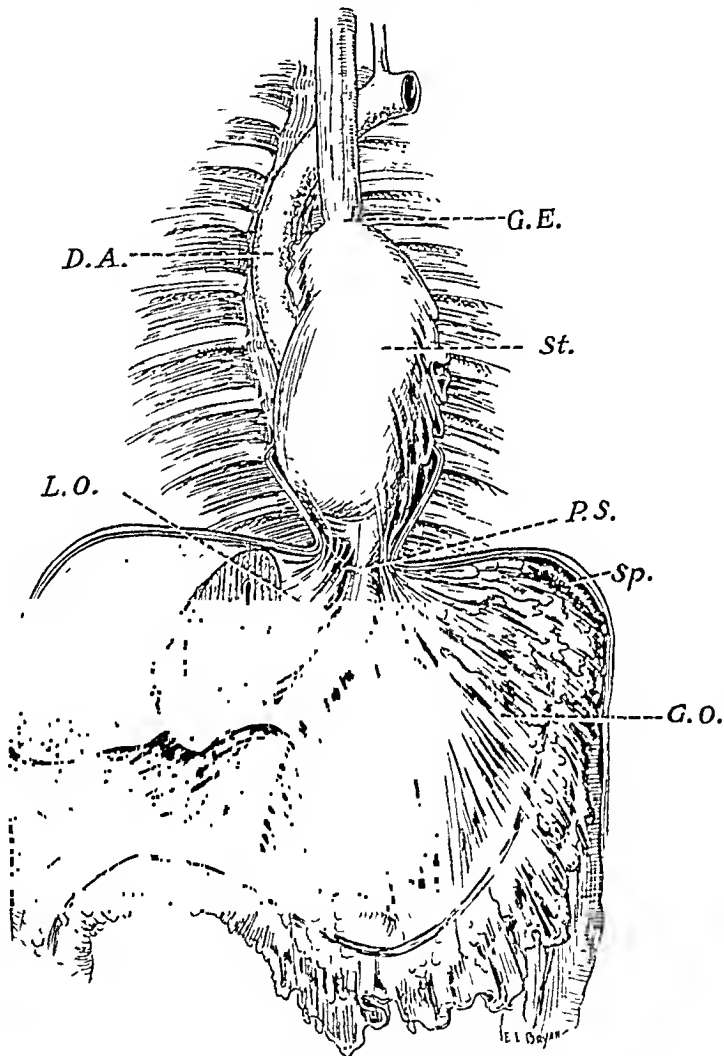


FIG. 4. (Case I.)—Diagram showing position of stomach and arrangement of peritoneum. (Note: The number of thoracic vertebrae and ribs shown is not accurate.) *D.A.*, dorsal aorta; *G.E.*, esophagogastric junction; *St.*, stomach; *P.S.*, pyloric sphincter; *L.O.*, lesser omentum; *Sp.*, spleen; *G.O.*, greater omentum.

the branches turned posteriorly, going deeper and deeper into the wall of the sac until the serous membrane was reached. The nerve fibers followed this serous layer dorsally until it became reflected on to the stomach; here these fibers were distributed to its left side.

The pleural and pericardial sacs showed no significant abnormalities. When the abdomen was examined, the rudimentary greater omentum was found knotted up in the left hypochondriac region. The liver was normal in gross appearance and location.

Only a very limited portion of the stomach showed from the abdominal aspect (Fig. 4). The pars pylorica extended vertically downward to the sphincter which was located 1.5 cm.

below the constriction at the diaphragm and 2 cm. to the right of the midline of the body. The duodenum continued downward for a short distance and curved slightly to the right to become situated along the right side of the vertebral bodies. This position was kept until the body of the fifth lumbar vertebra was reached where the gut crossed the midline to the left and ascended to the left side of the body of the second lumbar vertebra to the level of the duodenojejunal flexure. The gut below this flexure was normal in position.

The inlet to the sac-like dilatation of the diaphragm was oval shaped (2.5 cm. by 3.5 cm.), the long axis of the oval being placed transversely in front of the vertebral column at the level of the lower border of the tenth thoracic vertebra. Ventrally, the margin of the inlet was fibrous in character, while the dorsal boundary was muscular—the muscle fibers intervening between the inlet ventrally and the descending aorta and the vertebral column dorsally. The portion of the pars pylorica within the inlet was about 2.5 cm. in diameter, the remainder of the constriction being snugly filled with parts of the lesser and greater omenta.

The peripheral attachments of the diaphragm were normal. No abnormality other than the sac-like dilatation about the high placed stomach was noted.

The peritoneum below the transverse mesocolon presented no unusual features; but in the upper abdomen the relations and connections were peculiar. They can best be appreciated by reference to Fig. 4. The omental bursa possessed significant limitations.

Above the transverse mesocolon, the peritoneum was reflected upward as a single layer covering the dorsal body wall. Near the midline this layer ascended over the duodenum and pancreas and on upward through the constriction at the diaphragm over the pars pylorica. In other words, the pars pylorica and the duodenum were bound down by a single layer of peritoneum to the dorsal body wall; neither possessed any sign of a dorsal mesentery.

Along the right side of the upper part of the duodenum (for a distance of 7 cm. below the pyloric sphincter) and at a higher level along the ventral surface of the stomach, the peritoneum passed ventrally and slightly to the right as one layer of the lesser omentum. The layer became reflected upon itself to form the epiploic foramen (of Winslow) and to become continuous with the peritoneum lining the omental bursa. The so called "right free" border of the lesser omentum, together with its contents, had the appearance of being on the stretch and ran almost in the horizontal plane, thus maintaining in part the embryonic position (Figs. 4 and 5).

The omental bursa was found to be very limited. Inferiorly, it reached no farther than the level of the lower extent of the epiploic foramen which was about at its normal level. To the left the bursa was limited near the midline of the body where the posterior or right layer of the lesser omentum became reflected on to the duodenum and the pyloric portion of the stomach and then farther posteriorly on to the dorsal body wall. The omental bursa was found to continue upward through the inlet into the recess to the right of the stomach—as has already been pointed out.

Along the left side of the pars pylorica, beginning just above the sphincter, the sheet of peritoneum was brought forward and folded upon itself. This folding became quite redundant higher up on the stomach, being attached above to the rotated portion of the stomach along its greater curvature. The redundant double layer of peritoneum passed inferiorly through the constriction at the diaphragm and was connected below to the left half of the transverse colon as far to the left as the left flexure. Above the flexure the peritoneum was reflected about a spleen normal in size and position. After passing around the spleen and flexure, the left layer reflected laterally on the under surface of the diaphragm, left kidney, and body wall, while the more medial layer turned downward and medially and became continuous with the sheet ascending from the root of the transverse mesocolon.

The gastric circulation is worthy of note. The arterial supply along the left side of the stomach came mainly from the right gastro-epiploic. This vessel ran upward more or

FIG. 5. (Case I.)—Note the absence of the stomach and the horizontal direction of the "right free" border of the lesser omentum.

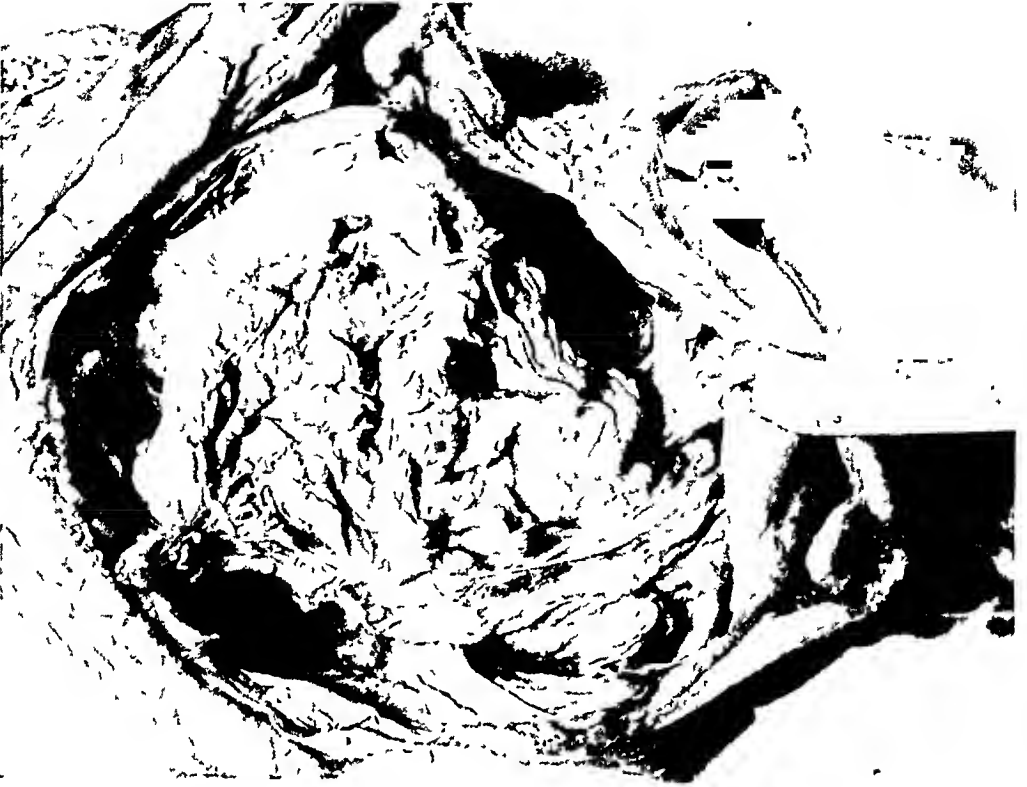


FIG. 6. (Case II.)—Shows tumor mass in posterior mediastinum.



less parallel with but about 3 cm. to the left of the stomach, giving branches over to the organ—mainly to the pars pylorica; a few branches passed downward toward the transverse colon and distributed themselves in the rudimentary greater omentum. No left gastro-epiploic artery could be identified. The splenic artery, however, gave off several small gastric branches; these coursed upward retroperitoneally through the constriction at the diaphragm to reach the upper part of the dorsal aspect of the left side of the stomach. Veins accompanying the above arteries were small.

On the right side of the stomach the main blood supply was from the left gastric artery, which arose normally from the celiac artery which coursed upward and ventrally. The left gastric artery came into the sac posteriorly near the midline, between the outer fibrous and inner serous layers, and extended upward as high as the esophagus, to which a small branch was given. The main vessel turned downward on the stomach between the layers of the lesser omentum. The right gastric artery was normal in origin and very small.

The coronary and right gastric veins were unusually large, perhaps as a result of partial suppression of venous return by pressure from the boundaries of the inlet to the sac during times of distension. Both of these veins emptied into the portal.

The pancreas was at its usual level and was essentially normal in position.

CASE II.—This subject was another Mexican female, F. E. No clinical history was obtainable except that she died at 70 years of age from cardiorenal disease.

The body was short, stocky, and obese. There was slight scoliosis, convex to the right in the upper thoracic region with a compensatory curve to the left in the lower thoracic and upper lumbar regions, combined with a mild lordosis in the lower lumbar region.

A soft tumor measuring 8 cm. by 10 cm. and extending as high as the lower border of the body of the fifth thoracic vertebra (opposite the sternal end of the third interspace) showed in the posterior mediastinum. The heart, normal in size, was displaced to the right.

The sac about the tumor contained better than half of the stomach and considerable parts of the greater and lesser omenta. The peritoneal connections within the sac were strikingly similar to those found in Case I. A narrow mesentery held the stomach close to the dorsal wall of the sac. This dorsal mesentery became continuous below with the greater omentum which was attached along the greater curvature of approximately the lower one-half or rotated portion of the stomach. The lesser omentum extended from an attachment near the ventral border of the stomach to the ventral wall of the sac, the line of attachment to the wall of the sac running to the right as it extended inferiorly. Below the level of the diaphragm the lesser omentum passed to the right and stretched from the porta hepatis to the lesser curvature of the rotated portion of the stomach.

The short esophagus became continuous with the stomach at the upper extremity of the sac. The esophagus was wider than normal, measuring 3 cm.; the width was uniform except below, where the esophagus was constricted to 2 cm. as it joined the stomach.

The inlet to the sac-like dilatation of the diaphragm measured 7 cm. transversely by 4.5 cm. anteroposteriorly and lay opposite the body of the tenth thoracic vertebra.

The liver, which appeared to be twisted to the right and displaced in that direction, was smaller than normal, particularly the left lobe. The pancreas and spleen were normal in size and position. In reaching the stomach, the arterial and nervous supply followed essentially the same course as found in Case I.

The great peritoneal sac was normal in significant features except for the extension of the space upward into the diaphragmatic recess anterior and to the left of the stomach. Likewise, the omental bursa narrowed and continued upward to the right of the upper part of the stomach retained in the recess.

SUMMARY.—(1) In each case the esophagus was shortened, ending caudally, in Case I at the level of the sixth thoracic vertebra and in Case II



Fig. 7. (Case II.)—Shows part of contents of sac.



Fig. 8. (Case II.)—Only about one-half of stomach is visible from abdominal aspect. Note inlet to sac.

ending at the level of the fifth thoracic vertebra; and a large part of each stomach was fixed above the usual level of the diaphragm.

(2) In both the diaphragm was essentially normal except for the sac-like dilatation stretched over the high placed stomach.

(3) The upper portion of each stomach was largely in an unrotated, vertical position—as evidenced not only by the position of the organ but also by the connections of the peritoneum, by the course and distribution of the vagus nerves, and by the arrangement of the gastric blood vessels.

(4) The greater and lesser peritoneal sacs were continued upward into the diaphragmatic recesses about the high placed stomachs.

DISCUSSION.—It is not possible to determine with certainty the mechanism of production of such anomalies as here seen; but, in view of the manner of development of the body cavities, foregut, and diaphragm, and in view of the arrangement of the parts in these cases, I believe that these abnormalities at the so called esophageal orifice are the result of a developmental arrest which took place during early embryonic life. While I have no new thought to offer concerning the probable primary cause of these developmental upsets, I feel it will be helpful to review briefly pertinent, diverse opinions in this regard and to point out the varied terminology used in describing such cases.

Primary Causal Factor.—In 1919, Bailey¹ reported a case in which he found, during the dissection of a man 77 years of age, the stomach in the thorax. Bailey explained the positions and relations of the parts “by supposing that the anlage of the stomach lay abnormally far anterior on the alimentary canal.” Such an explanation can neither be proved nor disproved.

Since the pleuroperitoneal canals of the embryo connect the pleural and peritoneal spaces, persistence of part of either of these canals has been used to explain the cause of certain so called herniae. An improper closure of one of the pleuroperitoneal canals more likely gives rise to an absence of diaphragmatic tissue between the costal and vertebral attachments of the diaphragm with direct communication between the pleural and peritoneal spaces and with the esophagus going through the esophageal opening normally.

Fraser² states that Browman, according to a private communication, feels that the infracardiac bursa may form at least a part of such a “para-oesophageal recess” and further suggests that the “muscle round the oesophageal foramen is either imperfectly developed, or has retrogressed (rückgebildet) and that abdominal pressure then forces up a pouch.”

Other observers have considered improper development of the esophagus to be the primary cause, and I feel that this explanation is most likely. Papers from this point of view have been written by Clerf and Manges,³ Monkhouse and Montgomery,⁴ Findlay and Kelly,⁵ and others.

In the cases here reported, suppose that, for some obscure reason, the esophagus in development failed to reach its normal length; and perhaps the esophagus widened to an abnormal degree—as we see in these specimens, the excess width possibly being related to the shortening. Subsequently, when the elements of the diaphragm were displaced caudally from the primitive

cervical level, instead of the esophagus elongating sufficiently to permit the stomach to be carried to its usual level, the stomach was anchored at a level higher than normal; and the elements of the diaphragm became stretched over the stomach to form a sac-like pouch. Since the peritoneal portion of the original coelom is about the primitive stomach, we should expect to find (as we did in these cases) the sac-like pouch of the diaphragm which stretched over the stomach to cover also this serous membrane about the stomach.

The unrotated position of the upper portion of each of these stomachs, associated with rotation to the left of parts of the lower portion, seems to indicate that the descending elements of the diaphragm caught the upper part and contributed toward inhibition of normal rotation; but the lower portion, which was reached later by the descending elements of the diaphragm, was allowed to rotate.

It is interesting to note that the portion of the dorsal mesogastrium which contained the spleen underwent a shift to the left in both cases. In Case I this shift with rotation of the adjacent part of the stomach occurred in spite of lack of rotation above or below. Hence, it appears that the migration of the spleen is to a large extent independent of the rotation of the stomach and is perhaps important in influencing the shift to the left of the dorsal mesogastrium to begin the formation of the greater omentum.

The question may be asked: Is the scoliosis exhibited by each of these cases related to the gut and diaphragmatic anomalies? I simply raise the question.

Terminology.—Complexity in development of the involved parts has led naturally to the use of a varied terminology in describing such abnormalities as here seen.

As already indicated, improper development of the esophagus has been regarded as the fundamental or primary cause. Hence, we see these cases referred to as the "congenitally shortened esophagus" or "short esophagus." These terms enjoy wide usage.

Perhaps the largest number of these cases has been diagnosed and recorded as "non-traumatic diaphragmatic herniae." However, the term "hernia" is now being reserved by some writers to apply to those cases in which the stomach or other abdominal parts were once down at their normal level and subsequently displaced to a higher level.

In a recent article Jackson and Jackson⁶ referred to a like condition as "supradiaphragmatic stomach." In their discussion they also use "hiatal hernia of the stomach" with apparently the same meaning.

A very similar condition, if not identical in essential features, is found in the case reported by Fraser.² He terms the abnormality "para-oesophageal recess of the diaphragm." Fraser thinks his case is the same type as one recorded by Gruber⁷ for which he proposed the name "recessus retramediastinalis phrenicoperitonealis." Fraser and Gruber have offered terms which are more accurate anatomically; but they are long and not in general use.

In the case reported by Bailey¹ he employed the term "thoracic stomach."

So far as I have been able to determine from the literature, this is the first recorded instance of the possibility of the stomach developing at a thoracic level. The term "thoracic stomach" has become quite generally used in referring to similar cases. LeVald⁸ wrote an excellent paper on thoracic stomach from the standpoint of the roentgenologist. More recently, Goodall and Hoyt⁹ reported five cases and gave an admirable discussion of the clinical manifestations of this condition. In addition to these observers, Lyons,¹⁰ Morris,¹¹ and others have reported cases and employed the term "thoracic stomach."

"Thoracic stomach" has the advantage over other suggested terms in that it is brief and can be remembered as a developmental disturbance in which the stomach has been retained at a level higher than normal. It must be admitted, however, that the term is not altogether satisfactory. Strictly speaking, it is not accurate. There is no continuity between the pleural or pericardial and peritoneal cavities. The stomach in such cases is not in the thoracic cavity but within an extension of the abdominal cavity. The stomach is below the over-stretched diaphragm. On the other hand, the stomach lies above the normal extent of the abdominal cavity and is at a thoracic level.

No doubt additional terms other than those mentioned have been employed. Suffice it to say, a varied terminology is being used to describe very similar conditions.

Frequency.—This variation in terminology used in reporting such cases makes it almost impossible to obtain accurate information concerning their frequency. The two cases reported here were found among 75 cadavers. Examination of the esophageal orifices and the esophagogastric junctions in all of these cadavers showed a third but less marked case. While I do not mean to infer that one out of every 25 cadavers will show some shortening of the esophagus with retention of part of the stomach at a level higher than normal, I do believe that such abnormalities are more frequent than is now generally recognized; and I trust that the report of these cases will serve to stimulate anatomists, pathologists, and clinicians to make more careful observations of the organs involved.

The author wishes to express his appreciation to Professor H. O. Knight for permission to publish these cases and to Professors Knight, Donald Duncan, and John G. Sinclair for their helpful suggestions and criticisms.

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EXTENSION OF GASTRIC CARCINOMA INTO THE DUODENUM

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THE majority of text-books of surgery and surgical pathology describe, very often quite dramatically, the abruptness with which the extension of gastric carcinoma stops at the pylorus. For example, Babcock¹ writes, "The growth tends to spread upward from the pylorus along the lesser curvature . . . , but it has no tendency to invade the duodenum." DaCosta² states, "Even in cancer of the pylorus the duodenum is seldom invaded." Thomson and Miles³ write, "The growth is arrested abruptly at the pyloric ring and shows no tendency to invade the duodenum." Romanis and Mitehiner⁴ write, "Here (the pylorus) the disease shows no tendency to spread into the duodenum." Boyd⁵ states, ". . . the spread stops short only when it reaches the duodenum." Many other authors could be cited, but these few will suffice to emphasize the idea that is generally accepted.

Verbruggen⁶ has recently reviewed the material at the Mayo Clinic and called attention to the extension of gastric carcinoma toward the cardia along the submucosa beyond the visible edge of the tumor. He advised that in resecting the tumor at least four cm. of normal gastric wall should be allowed from the edge of the ulcer along the lesser curvature toward the cardia. In very diffuse carcinoma there may not be any visible edge and a proper point for resection could not be indicated. He says nothing about duodenal extension.

Since many surgeons believe that only a very small margin of duodenum need be resected for carcinoma in the distal third of the stomach, and since so many text-books state that the duodenum is immune from extension of gastric carcinoma, I have reviewed some of the microscopic preparations from both surgical and autopsy material collected during the past 30 years. Before analyzing this material, however, a review of the literature including the reasons for the prevalent point of view may be in order.

Rokitansky⁷ in 1861 laid down the law, as it were, when he said that pyloric cancer was exactly bounded by the pyloric ring, and never reached beyond that to the duodenum. Both Kocher⁸ and Mikulicz⁹ believed very strongly in the integrity of the duodenum and stated that the duodenum could be resected with safety five to ten Mm. from the pyloric valve.

In 1865 Brinton¹⁰ was the first to take exception to this rule. In 125 cases of pyloric cancer he found ten that had invaded the duodenum for a variable distance, often as much as an inch or two. He also cited a case of Lebert, making 11 cases in all. Carle and Fantino¹¹ found the duodenum invaded for distances of one to three cm. in three out of 14 cases. Cuneo¹² studied eight gastrectomies and found one in which the duodenum was grossly invaded; in

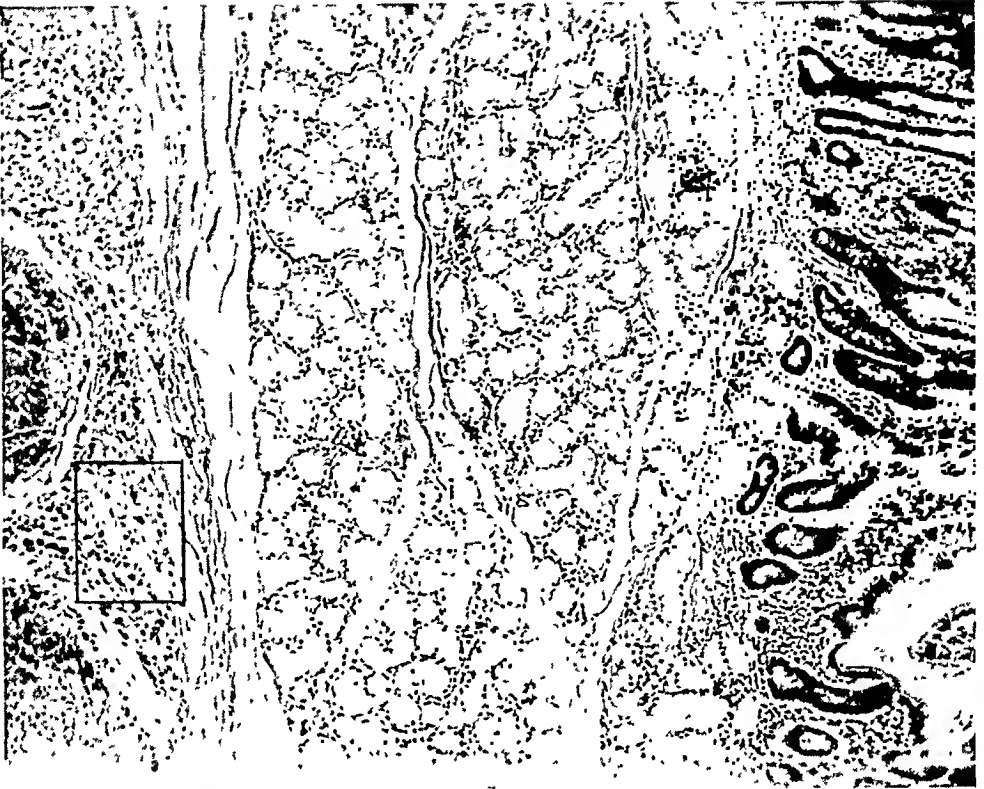


FIG. 1. (Case 14.)—A low power photomicrograph of a section of duodenum showing two large collections of carcinoma cells between Brunner's glands and the muscularis.

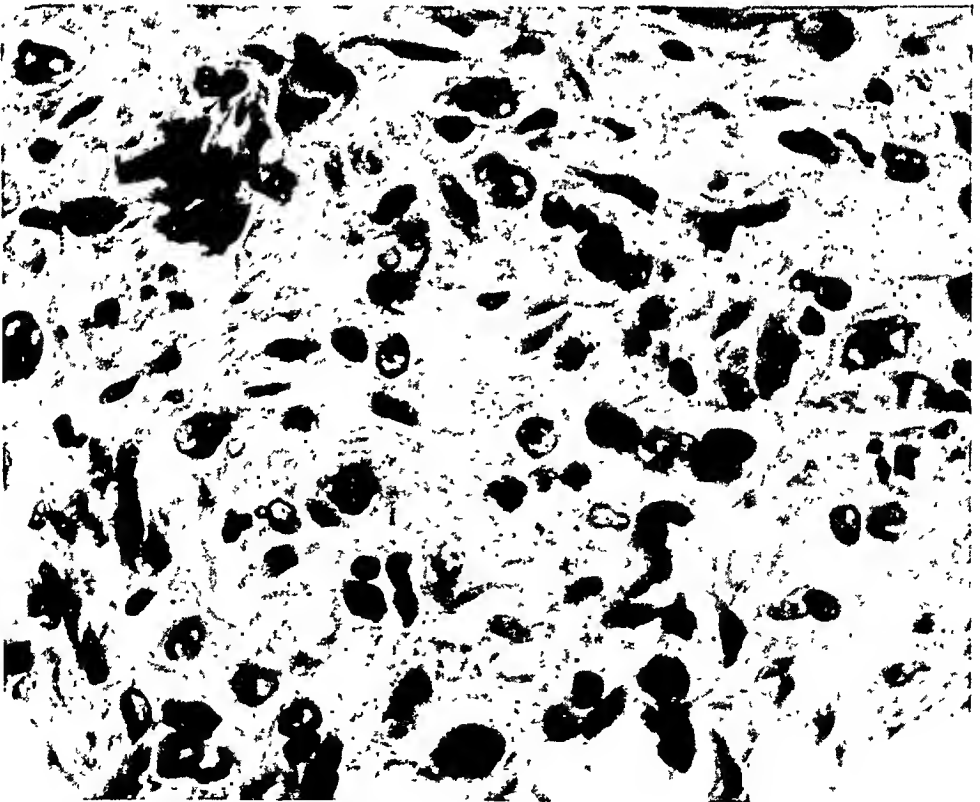


FIG. 2. (Case 14.)—A high power photomicrograph of the blocked area in Fig. 1.



FIG. 4. (Case 8.)—Photomicrograph of a section of the duodenal wall showing carcinoma within the lymphatics. Note the three small lymphatics in the upper left hand corner.



FIG. 3. (Case 10.)—Photomicrograph of a section of duodenum showing carcinoma diffusely infiltrating the muscularis. Note Brunner's glands in the upper left hand corner.

three of the remaining seven there was some invasion, the greatest being one cm. In 1901 Borrmann¹³ studied 63 cases and found the duodenum invaded in 20, in nine of which involvement was at the line of resection, and in two, over two cm. from the pylorus. Moynihan¹⁴ cites many of these references and emphasizes quite strongly the necessity of removing most of the first portion of the duodenum.

Statistical Data.—From 1900 to 1931 at the Massachusetts General Hospital there were 65 autopsied cases of carcinoma involving the pylorus. In many of these cases sections from the tumor only, without duodenum, were preserved. In reviewing these cases, however, it was possible to find six in which the growth had invaded the duodenum.

During the years 1919 to 1934 inclusive, the laboratory received 134 surgical specimens of stomach resected for pyloric carcinoma. In some specimens, as in the autopsy group, sections of the duodenum were not preserved, but making no allowance for these, 15 specimens of the 134, or 11 per cent, showed duodenal extension.

In 1934, when special attention was given to this subject, there were seven out of 28 surgical cases, or 25 per cent, that showed duodenal extension. This high percentage emphasizes quite clearly the necessity for the pathologist to take sections of the duodenum in all cases of prepyloric carcinoma.

The 21 cases thus selected, the six from the autopsy group and the 15 from the surgical group, all showed microscopically definite carcinoma for varying distances beneath Brunner's glands (Figs. 1 and 2). The extension rarely involved the mucosa, but spread along the submucosa (Fig. 3), often in lymphatics (Fig. 4). The extent of the duodenal invasion was measured in millimeters from the microscopic slide and because of the marked shrinkage in the tissues, due to fixation and dehydration, the figures were corrected to correspond to the gross specimens. This degree of shrinkage for tissues fixed in Zenker fluid, dehydrated in the alcohols and xylol, and imbedded in paraffin, was found to be approximately 20 per cent.

Nine out of the 16 pylorectomies showed tumor cells at the extreme edge of the resection, apparently indicating that there was still carcinoma present in the remaining duodenum; in only six was normal duodenum present beyond the farthest deposit of carcinoma. The sections from the autopsy cases were cut too short, because all six showed tumor at the extreme cut edge.

DISCUSSION.—The significance of the statistics presented in the Table I is quite obvious; namely, that the surgeon should resect more duodenum. The first portion of the duodenum measures on the average five cm. This length should allow the surgeon to resect at least three cm. beyond the pylorus and still leave enough to fold in in the distal portion. If this procedure were followed there certainly would be fewer specimens showing tumor at the distal cut edge and less recurrence along the line of closure. In one case where the infiltration extended for 23 Mm. the surgeon was able to palpate the thickened duodenal wall, but usually the infiltration is so slight that only careful microscopic examination can detect its presence.

TABLE I

Case No.	Distance of Duodenal Extension (in Mm.)	Normal Duodenum beyond Carcinoma	Case No.	Distance of Duodenal Extension (in Mm.)	Normal Duodenum beyond Carcinoma
1 [*]	4	0	12.....	6	0
2 [*]	10	0	13.....	6	+
3 [*]	12	0	14.....	6	+
4 [*]	14	0	15.....	7	+
5 [*]	17	0	16.....	8	0
6 [*]	First portion	0	17.....	11	0
7.....	4	0	18.....	11	0
8.....	4	+	19.....	13	?0
9.....	5	0	20.....	13	0
10.....	5	+	21.....	23	0
11.....	6	+			

* Autopsy

SUMMARY AND CONCLUSIONS

(1) Twenty-one cases of carcinoma of the pyloric end of the stomach are presented in which there was extension of the tumor into the duodenum. Fifteen of the cases were partial gastrectomies, and six were autopsy cases.

(2) The degree of extension varied from four to 23 Mm. and in most of the surgical specimens carcinoma cells were found at the distal cut edge, implying that the remaining duodenal tissue contained tumor.

(3) It is suggested that at least three cm. of duodenum should be removed with all gastric resections for carcinoma at the pylorus, despite the fact that many of the text-books of surgery and surgical pathology state that gastric carcinoma does not extend beyond the pylorus.

(4) These findings indicate quite clearly the need for careful microscopic examination of the duodenum in all cases of pyloric carcinoma.

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GASTRIC AND DUODENAL PERFORATION DURING HOSPITAL TREATMENT

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PATIENTS with known gastric or duodenal lesions perforating while in the hospital under standard, acceptedly efficient medical regimen are rarely encountered. Six such cases have occurred in Receiving Hospital during the last 15 years, and five of these within a recent three month period. The first was included in a previous report.¹ Another case of unsuspected ulcer perforated acutely while undergoing hospital treatment for an unrelated condition. Five of these were benign lesions and two were malignant. That the mortality rate should be 100 per cent is somewhat disconcerting, especially when, as Shawan² has shown, we have had unusual opportunity for experience in diagnosis and treatment of such cases. (His report included 227 acute perforations to January 1, 1933. Since that time this number has been increased to 289 as of July 1, 1935.) However, we believe it has been of distinct value to us to review these cases together as some unusual features become emphasized.

CASE REPORTS

CASE I.—B. S., a white male, aged 46 years, was admitted March 3, 1921, complaining of pain in the stomach, belching and heartburn. For eight years he had been having intermittent attacks of dyspepsia of four or five days' duration. During the previous year he had had almost constant moderate pain throughout the day, with severe pain coming on about three hours after the evening meal, accompanied by heartburn and relieved by vomiting. He avoided heavy and fat foods. There had been no hematemesis or jaundice.

The Wassermann was positive and the gastric analysis showed 56 degrees of free HCl and a total acid of 75 degrees. The roentgenographic examination showed 60 per cent retention of barium at six hours. The 24-hour plate showed 25 per cent retention. The impression was that the pyloric obstruction was due to ulcer.

On March 5, the patient was placed on a Sippy diet but continued to complain daily of severe abdominal pain. On March 10, early in the morning, the patient suddenly cried out with pain. The intern found marked rigidity of the abdominal wall but did not recognize the condition. Later in the morning the medical resident recorded the following: "The patient is on a very scanty diet, but still has attacks of pain. He is much weaker this A. M. and the pulse is very rapid and weak. There is definite rigidity of the abdomen and complaint of pain on palpation. The leukocytosis is 10,000. Impression: Ruptured ulcer."

Following diagnosis there was further delay in operation as the patient refused permission until his mother arrived. Nine hours following perforation the operative findings were as follows: "A large markedly indurated perforated ulcer is present on the superior surface of the first part of the duodenum. The perforation admits the little finger. There is no local evidence of attempt to wall off. The perforation is closed and a posterior gastro-enterostomy performed. The abdomen is drained suprapubically." Following operation he reacted very feebly and expired on March 11 at 7:15 P. M. No autopsy was obtained.

This patient, then, with an eight year history of chronic dyspepsia and a one year history of typical ulcer syndrome, perforated in the hospital on the fifth day of his Sippy diet. Following perforation, due in part to the delayed recognition of the condition and in part to the patient's own insistence, there was nine hours delay in operation. This delay and the performance of a gastro-enterostomy in the presence of a rapid, weak pulse were factors tending toward an unfavorable outcome. Note the history of daily severe upper abdominal pain.

CASE II.—P.R., a white male, 55 years old, was admitted to the Redford Branch, November 5, 1932, having been struck by an automobile. There was a fracture of the right clavicle and a compound fracture of the right leg. No laboratory examinations were made.

The fractures were treated and the patient was progressing favorably under bed rest and a soft diet. His only complaint up to the morning of November 26 was some pain at the sites of fractures. There was no nausea, vomiting, or gastric distress.

At 5:40 A.M. on November 26 he complained of severe pain in the stomach and side, became nauseated and vomited. He had had codeine Gr. $\frac{1}{4}$ at 8:00 P.M. and this was repeated at 5:40 A.M.

A progress note on the clinical record describes the findings of ruptured ulcer as being fairly typical. The abdomen showed marked rigidity with great tenderness and the temperature, pulse, and respirations were entirely normal. However, in as much as the patient was not operated upon until 3:35 P.M., it seems reasonable to suppose that the diagnosis in the morning was not quite so obvious.

At operation a large amount of bile stained fluid escaped. A perforation about 1 cm. in diameter was found practically at the pyloric junction on the anterior surface. Simple closure was performed and drainage of the right gutter and pelvis was instituted. The patient left the operating room in poor condition and expired 24 hours later.

While this patient was not on an ulcer regimen, bed rest and soft diet might be expected to treat an existing ulcer kindly. Unfortunately, the record does not show any questioning in regard to previous gastric history. Trauma sustained at the time of injury may be mentioned as a possible causative factor. The nine hour operative delay reduced the chance for recovery.

CASE III.—D.J., a colored male, aged 47 years, was admitted October 18, 1934, complaining of midepigastria pain, persistent hiccup, and generalized weakness. This was his fifth hospitalization in six years, each admission being in the fall, and the complaint being essentially the same each time. Relief was obtained in from 4 to 20 days on these various occasions. A deformed duodenal cap was seen on the third admission, and on the fourth a definite penetrating duodenal ulcer.

On the final admission he said that four days previously he had been awakened by a vague "tight, gnawing" pain to the right of and slightly above the umbilicus. He had been on an ulcer diet since the previous admission but had not had as complete relief as he had formerly enjoyed. For two days previous to admission he had been unable to retain anything. On examination there was a marked icteric tinge to the sclerae, and a moderate degree of muscle splinting in the right upper quadrant of the abdomen, with tenderness. Laboratory findings: Hb., 12.2G. R.B.C., 5,030,000. W.B.C., 9,950. Serology, neg. Icteric index, 16. Urine, neg.

Roentgenography of the G.I. tract October 20 showed a penetrating defect, on the lesser curvature of the pylorus at the duodenal junction, with localized tenderness, and no retention.

Although on a rigid Sippy diet and intravenous injections of synodal from the time of

admission, there was persistence of upper abdominal pain for which a potent sedative or narcotic was administered nearly every day. There was no abdominal rigidity at any time. Operation was advised but refused until October 29, when, following three days of particularly severe pain, he consented and operation was scheduled for the following day.

On the morning of October 30 at 4:30 A.M. the intern was called to see the patient who was in extreme agony. The abdomen was board-like and exquisitely tender. The surgical resident was notified and the patient was taken to the operating room at 5:30 A.M. An ulcer, 2 cm. in diameter, was found situated 5 cm. distal to the pyloric vein. In its central portion there was a perforation .5 cm. in diameter. The abdomen contained a large amount of dark green fluid. Simple closure, jejunostomy and abdominal drainage was done.

Following operation his condition remained quite poor. He continued to have abdominal pain, and some hiccoughing; developed severe infection of the wound and anterior abdominal wall; and, following a gradual decline, expired November 26.

At autopsy there was found severe infection of the abdominal wall, multiple intra-abdominal abscesses between coils of intestine and above the stomach; and two chronic perforating ulcers, one in the duodenum, which had recently been repaired, and one prepyloric.

The long history under treatment indicates a resistant lesion, and the severe and persistent pain suggests an actively penetrating ulcer. A study of the films after autopsy shows that both penetrating ulcers were present at the time of roentgenologic examination. This patient had been on an ulcer regimen for one year. He had been on bed rest and rigid Sippy diet in the hospital for 12 days prior to perforation without much effect upon his severe, persistent, upper abdominal pain. Death occurred in spite of very early and competent operation.

CASE IV.—L.S., a white male, aged 43 years, was admitted November 22, 1934, complaining of constipation for eight days. During an admission in October, 1929, he had complained of epigastric pain before meals relieved by eating and sometimes followed by vomiting. No hematemesis or tarry stools. Roentgenography had shown a penetrating ulcer on the lesser curvature; there was occult and microscopic blood in the stool but no anemia; and, after 16 days on a Sippy diet, he had become symptom free and was discharged.

He was readmitted at this time to the Proctologic service with the diagnosis of carcinoma of the sigmoid. He complained of crampy lower abdominal pain after eating, nausea, and vomiting. He had lost 40 pounds in the last year and 8 pounds in the last ten days.

The positive findings on physical examination were that the patient was emaciated, breath sounds were depressed over the upper third of both lungs with question of fine râles at the right apex on inspiratory cough. Rectal examination showed slight enlargement of the prostate. The abdominal examination was entirely negative. Laboratory findings: Hb., 10.6G. R.B.C., 2,940,000. W.B.C., 11,200. Kline, neg. Urine, neg. Blood in stool.

On November 24, sigmoidoscopy was done, revealing no pathology, although there was old blood in the lower rectum. On November 26, he vomited about 500 cc. of bright red blood, and was accepted on the medical service as a bleeding peptic ulcer. On November 27 the blood picture was Hb., 4.8G., and the R.B.C. 1,800,000. He was treated for this condition by appropriate methods until December 21, a period of three weeks, at which time the Hb. was again 10.4G. with the R.B.C. 3,560,000.

Roentgenography of the G.I. tract on December 19 revealed a large penetrating defect on the lesser curvature midway between the cardia and pylorus and measuring 3 cm. in diameter at the base, and 2 cm. in depth. There was evidence of rigidity of the wall on the lesser curvature above and below the lesion and 90 per cent retention at

the end of six hours. Impression: Large penetrating ulcer of the stomach, probably malignant.

On December 21, it was planned to do a rapid exploration and jejunostomy for feeding while resting the stomach. The operative dictation follows: "There is a large ulcer about the midportion of the lesser curvature, which is about one inch in diameter, including induration. It is quite firm and is sharply limited. There are no regional palpable nodes. It is attached posteriorly. While this could easily be malignancy, on the basis of the gross findings we must call it an ulcer. It is resectable. A jejunostomy was done."

Following operation the patient received nothing by mouth until January 1, 1935, when he was allowed ice chips occasionally. Feedings and medications were given by jejunostomy tube. He continued to complain of some hypogastric pain which was considered due to some fault in jejunal feeding, but was progressing favorably and was up and about the ward. He gained in weight but the amount was not recorded. On January 9, the Hb. was 12.8G. and the R.B.C. 3,800,000.

On January 15, 22 days after operation, the patient appeared rather stuporous when awakened but made no complaint. The previous day he had felt well. At about 10:00 A.M. he seemed so unusually ill that attention was called to his condition. He had complained of no pain and there were no unusual abdominal findings. He was unconscious at noon, and it was thought embolism might have occurred. His temperature rose from normal of the previous day to 104.7°, the pulse to 130 and the respirations to 24. He remained in state of collapse in spite of stimulation and expired at 4:45 P.M.

At autopsy there were about 1,000 cc. of fluid present in the abdominal cavity, and a perforation of the stomach on the lesser curvature midway between the pylorus and cardia was found. The perforation measured about 2 by 4 cm. There was only a slight amount of induration about the perforation. There were a few soft nodes about the greater curvature of the stomach. There was no leakage about the jejunostomy tube.

In this case, one and one-half months following a severe gastric hemorrhage, where an ulcer seems to have existed at least five years, and, in spite of rigid Sippy diet for the first half of this period, plus absolute gastric rest as afforded by jejunostomy during the second half, there was perforation. Another unusual feature is that, in spite of the large size of this ulcer, malignancy could not be demonstrated at autopsy and most of the induration had disappeared. In addition, the shock of perforation was extreme and the ordinary symptoms and signs were absent.

CASE V.—C. H., a white male, aged 53 years, was admitted January 10, 1935, complaining of epigastric pain with vomiting. There had never been any stomach trouble whatsoever until about three weeks prior to admission, when he began to have a dull epigastric ache coming on one half hour following meals. It was relieved somewhat by food, particularly milk, and by soda. He was awakened at about 3:00 A.M. by pain. At times it persisted throughout the day and was occasionally absent for an entire day. During the same period he had vomited six or eight times, always following the evening meal. There was hematemesis one week previous, and the stools had been black. There had been a weight loss of 20 pounds in three weeks.

On examination, the patient was a large framed, heavy set, middle aged man showing slight epigastric tenderness. Laboratory findings: Hb., 9.G. R.B.C., 3,700,000. W.B.C., 9,150. Kline, neg. N.P.N., 37.5. Chlorides, 346. Urine, neg. The gastric analysis showed free HCl in all specimens with a total acidity of 114 degrees, and a trace of occult blood. Stool showed occult and microscopic blood.

On January 8, roentgenologic study of the G.I. tract revealed a large penetrating

defect 3 cm. in diameter at the base, and 1.5 cm. in depth, situated on the lesser curvature 5 cm. above the pylorus. At six hours there was slight retention of barium.

On January 10, the patient was placed on Sippy diet. Three days later, at 10:00 P.M., he experienced a sharp upper abdominal pain which radiated to his left shoulder. He felt faint and dizzy and it was noted that he was in a mild degree of shock. He complained of no extreme pain but rather of a severe dull ache. He was seen by the intern and the medical and surgical residents. The intern noted on the chart that there was no abdominal rigidity but was of the impression that the patient had had a small perforation. At this time the condition suggested a coronary attack. The next morning, leukocyte count was 15,000 with 93 per cent polymorphonuclear cells. There was still no abdominal rigidity, although there was generalized abdominal tenderness with rebound tenderness and questionable obliteration of liver dullness. An electrocardiogram in the morning showed some findings suggestive of coronary thrombosis and therefore helped to delay action. It was repeated in the afternoon and was negative.

Fluoroscopy of the diaphragm was reported as follows: "There is an elevation of the left leaf of the diaphragm which was not present at the time of the G.I. examination. There is marked restriction in the excursion of the left leaf. There is no free air in the peritoneal cavity. In view of the presence of the large penetrating ulcer, we feel that the findings suggest leakage of the ulcer."

The patient had been placed on an Ochsner regimen and did fairly well but that evening when the temperature rose to 100.6°, he was operated upon, about 20 hours after onset of pain. The findings were as follows: "There is no gas or free fluid upon opening the abdomen. There are recent plastic adhesions between the stomach and the liver. On separating these a sloughing area about one and one half inches long and about one inch wide at its widest portion is found on the anterior surface of the stomach next to the lesser curvature. There is no gas or air and careful examination does not disclose any point of actual perforation. It appears that the stomach wall is breaking down over this area, resulting in infection rather than frank perforation. The left side of the greater omentum is drawn up and sutured over the defect in the stomach. There is purulent fluid in the pelvis. A stab wound drain is placed suprapubically."

Following operation, the patient did well for three or four days. His abdomen became distended, however, and he had a partial wound disruption. The T.P.R. remained high. He developed a paralytic ileus and expired January 23, nine days after operation.

At autopsy a purulent peritonitis was found. "On the anterior wall of the stomach 3 cm. proximal to the pylorus, is a large ulcerated area, measuring 3 cm. in length and 5 cm. in width. In the center of this area is a 5 Mm. perforation through the ulcer base. There is a firm ring of induration surrounding this point of perforation on the external surface of the stomach."

Here again we have a quite large gastric ulcer without autopsy evidence of malignancy. The perforation was atypical in that there was no marked abdominal tenderness or rigidity, and this probably because of a dissolution of the ulcer base somewhat gradually, rather than a sudden bursting through. There was also perforation shortly following hemorrhage. The perforation was preceded, however, by almost daily, quite severe, upper abdominal pain of three weeks' duration, and occurred while the patient was on bed rest and Sippy diet.

CASE VI.—H. H., a white male, aged 53 years, was admitted November 16, 1934, complaining of vomiting, abdominal pain, loss of weight and constipation. In March of 1934, the patient began to have attacks of vomiting and severe constipation. He was treated elsewhere for these complaints in April without relief. Treatment consisted of large white pills taken four times a day. Roentgenologic examination at that time showed

what appeared to be a very small lesion on the lesser curvature, which was considered a beginning penetrating ulcer.

In July, 1934, he began having pain about the umbilicus which was of burning type and worse after eating a large meal. At this time he was told he should have an operation on his stomach. From July until admission the vomiting, umbilical pain and loss of weight had become progressively worse. He had lost 70 pounds in one year. There had been no hematemesis but there had been some tarry stools.

Examination showed an elderly, emaciated, white male, with marked sclerosis of the peripheral vessels. The B.P. was 120/80. The abdomen was soft and flat and there was considerable tenderness about the umbilicus. There was a questionable mass in the epigastrium slightly to the left of the midline which was not tender. The liver extended two finger breadths below the costal margin. Laboratory findings: Hb., 10G. R.B.C., 3,540,000. W.B.C., 16,500. Kline, positive. N.P.N., 39. Chlorides, 396. Urine, neg. The gastric analysis showed no free HCl, total acid of 145 degrees, lactic acid, Boas-Oppler bacilli, yeast and occult blood all positive. There was occult and microscopic blood in the stool.

Roentgenography of the G.I. tract on November 21 showed the esophagus slightly dilated. "As the barium enters the cardiac portion, the mucosa appears markedly irregular but there is no abnormality in the contour of the gastric wall. There is an irregular filling defect involving the prepyloric portion and antrum with an irregularity of the wall on the lesser curvature to the midportion of the stomach. There is 95 per cent retention in six hours and 60 per cent at 24 hours. Impression: Carcinoma of the pylorus with questionable involvement of the cardia.

On December 3, he was transferred to the surgical service for operation on the following day. His stomach was not lavaged the evening prior to operation. Although given ten grains of barbital, the patient was unable to sleep, and the intern was called to see him at 4:00 A.M. because of severe pain on the left side of the abdomen. He ordered morphine Gr. $\frac{1}{4}$, but wrote no note of the patient's condition. In the morning he was seen by the surgical resident, who found some distention of the abdomen but no pain on palpation. The abdomen was doughy and not rigid. He was operated upon at 9:30 A.M., the dictation being as follows: "There is a perforation on the lesser curvature about one and one quarter inches from the pylorus with gastric contents discharging. The perforation was closed satisfactorily and the omentum tacked over it. The extent of the carcinoma and metastasis was so great that a retrocolic gastro-enterostomy could not be done. For that reason, an anterior gastrojejunostomy was necessary. The abdomen was drained through stab wounds. A lymph node was taken from the greater curvature for biopsy."

Following operation his condition remained poor, and he expired on December 7. The pathologic report was medullary adenocarcinoma of a prepyloric lymph node. No autopsy was obtained.

Perforation was again atypical, there being no abdominal tenderness or rigidity. The usual gastric lavage had been omitted the evening prior to operation and so was not a factor in causing perforation. Since admission to the hospital he had been on bed rest and soft or fluid diet.

CASE VII.—J. R., a colored male, aged 43 years, was admitted January 4, 1935, complaining of severe pain in the right upper quadrant, nausea and vomiting. These symptoms had been intermittently present for 12 years. There was relief from soda, vomiting and food. The severity of symptoms had gradually increased during the previous month. No hematemesis, tarry stools, or weight loss prior to admission. Gastric ulcer had been diagnosed by roentgenography at another hospital five years previously.

The patient was a fairly well developed colored male, nauseated and in great pain. The heart was not enlarged, the blood pressure 170/120, and there was an occasional

dropped beat. The abdomen was soft, not distended, no areas of tenderness, no rigidity, and no tumor masses. Laboratory findings: Blood, 1-4-35:Hb., 11G. R.B.C., 3,900,000. W.B.C., 15,200. Kline, negative. N.P.N., 28. Chlorides, 330. CO₂, 55. Calcium, 12.3. Bleeding time, two minutes. Clotting time, four and one half minutes. Icterus index, 4.5. Urine, neg. Gastric analysis showed free HCl, in all specimens, total acid 80 degrees, gross and occult blood positive, W.B.C., five; R.B.C., 40. Stool—occult and microscopic blood. Graham-Cole test showed non-visualization of the G.B.

Roentgenography of the G.I. tract on January 5 showed "a stomach of cascade type with marked hypertrophy of the rugae. Duodenum is visualized with difficulty revealing a persistent deformity of the cap and slight dilatation. There is about 10 per cent retention of barium in the stomach at six hours.

"Impression: Duodenal ulcer with chronic gastritis." (The roentgenologist requested a reexamination.)

He was placed on Sippy diet pending surgical interference. This afforded meager relief from symptoms and on January 16 it was proposed that he be operated on the following day. However, at 8:00 P.M. that evening he had a copious hematemesis of two liters of blood and gastric content. The B.P. dropped to 78/60, and the R.B.C. to 1,410,000 and the Hb. to 3.6G. He showed at this time, no signs of peritoneal irritation. The patient's shock was treated and the scheduled operation cancelled. He was transfused on January 17, and on January 19, each time 500 cc. being transferred by the direct method. Following this his condition became much improved and the Hb. reading was 7.4G. with R.B.C. 2,500,000.

On January 21, he was operated upon with the intention of doing the simplest procedure which would prevent further hemorrhage. There was severe collapse following injection of spinal anesthetic (pantocain). Restorative measures were effective and his condition warranted the rather imperative operation. "The pylorus and duodenum are perfectly normal. There is a very definite new growth involving the lesser curvature for a distance of about two inches, at just about the midportion. There is some adhesion to the pancreas, but it is thought this can be separated. Condition of the patient at present does not warrant a subtotal gastrectomy. Therefore, a regional lymph node along the greater curvature is removed for pathologic examination. The liver is normal."

Following operation the condition of the patient was only fair and on January 22 a small transfusion was given. That night and the next morning the patient complained of severe upper abdominal pain. In the morning there was increase in the degree of distention, tenderness on palpation of the lower abdomen, but no marked rigidity. Perforation as a complication was suggested, but did not seem to be supported by the findings. Check of the blood count showed elevation of W.B.C. to 18,500. He expired at 1:30 P.M. on January 24.

Autopsy report: "There are about 1,000 cc. of dirty fluid in the abdomen. There is a plastic exudate on the small bowel. Upon the anterior surface of the lesser curvature of the stomach, 5 cm. from the pyloric end of the stomach, is a perforation measuring 3 cm. by 1.5 cm. Upon opening the stomach along the greater curvature there is found a large, indurated, punched-out area, measuring 8 cm. by 4 cm. This area is on the posterior surface of the stomach and has the appearance of being malignant. No gross evidence of metastasis." It was only after repeated sections had shown chronic gastric ulcer that an area of definite malignancy was found, thus supporting the diagnosis of a primary chronic gastric ulcer with recent malignant degeneration.

Perforation in this last case followed so soon after operation that it is possible, although we feel not likely, that exploration of the upper abdomen may have been a factor. Perforation took place while the stomach was at rest and following 17 days' treatment on Sippy diet. Again the findings were atypical in that there was no increase in abdominal tenderness or rigidity

and the complication was only suggested because of recent experience. There had also been recent hemorrhage.

In the hope of finding other similar cases reported, the voluminous ulcer literature was gone over by title without success. However, two cases were picked up in going through articles at random. Doubtless others could have been found by a complete search, but the relative scarcity is evident. Singer and Meyer³ describe a man who entered the hospital because of a known jejunal ulcer causing much pain. After two days of diet and alkali the condition became acute. Perforation here was not recognized at once. By the time the diagnosis was established sufficient time had elapsed to make it seem wise to temporize, especially since the patient's condition was improving. This proved to be good judgment since an abscess formed, and was drained 12 days later with recovery. Dowdle's⁴ case is remarkable in that a second ulcer perforated six days following rupture and closure of a first. The catastrophe interrupted a smooth convalescence, and it was thought that leakage at the suture line had occurred. As in our cases the termination was fatal.

A patient in the hospital with a diagnosis established and accepted by nurses as well as doctors, who is more or less regularly having definite pain, may have a perforation which is unrecognized for from a few to several hours, because it is considered to be only a more severe exacerbation of the pain he has been having. Only the typical board-like rigidity of the abdomen may force the diagnosis on the unsuspecting intern. Indeed, one complained of lack of cooperation on the part of the patient because he "would not relax his abdomen" so he could be properly examined. Patients who have recently

RÉSUMÉ OF RELEVANT DATA

Prior to Perforation

Case	Pain	Hem.	In Hospital	Ulcer Regimen
1	71 days	None	7 days	5 days
2	Few hrs.	None	22 days	Soft diet
3	16 days	None	12 days	11 days
4	62 days	50 days	54 days	50 days
5	3½ wks.	10 days	3 days	31 days
6	4½ mos.	Recent	18 days	Fluid diet
7	2 mos.	6 days	18 days	11 days

DIAGNOSIS OF LESION

Before Perforation

Of Perforation

1. Yes.....	4 hrs.—typical
2. No	8 hrs.—typical
3. Yes.....	At once—typical
4. Yes.....	Not suspected
5. Yes.....	By intern at once—staff 12 hrs.
6. Yes { Ulcer in March Ca. in November }	Not suspected
7. Yes { Ulcer before operation Ca. after operation }	Considered but rejected

been operated upon are in a more unfortunate position. It is very difficult to separate new symptoms and physical findings with sufficient clarity to warrant immediate reoperation. Fluoroscopic demonstration of air underneath the diaphragm may be the only way in which this can be justified. The condition rapidly progresses to the point where operation is hopeless. It is rather a paradox, but the patient who perforates while in the hospital has less chance of recovery than the one who brings his perforation to the hospital.

COMMENT

(1) The frequently repeated statement that "a bleeding ulcer will not perforate and a perforating ulcer will not bleed" cannot be relied upon. This is particularly true in gastric ulcer.

(2) We cannot feel secure that when we have placed an ulcer case on the most rigid regimen he is immune to perforation.

(3) A grave responsibility must be assumed by the physician or surgeon who does not advise operation for a patient with a known or strongly suspected gastric or duodenal lesion causing persistent pain.

(4) Because the ulcer cases here cited perforated under conditions most favorable for healing, and because in spite of very early operation in one and fairly early in two others, all died with a purulent peritonitis, we may suspect a more virulent organism resident in such ulcers.

(5) Acute perforation may be a complication of carcinoma of the stomach.

(6) Symptoms are apt to be sufficiently atypical or clouded by an associated condition to be inconclusive.

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FACTORS IN THE MORTALITY OF ACUTE APPENDICITIS

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THIS report is based on a study of the cases of acute appendicitis admitted to the University Hospital, Iowa City, Iowa, a State Hospital primarily for indigent patients, which receives its clientele from a radius of over 300 miles. The series includes 1,211 patients admitted during the 15-year period from 1919 to 1934, all of whom were operated upon with the exception of three patients who were moribund on admission.

Because of the voluminous literature on all phases of acute appendicitis, it is not proposed to discuss the factors influencing the mortality but it is desired mainly to give the results of this investigation; for the most part in tabular form.

The reasons for this study were two-fold: first, to determine if our mortality rate has been increasing, as has so frequently been reported elsewhere; and secondly, to determine factors through which we may be able to reduce our present mortality rate.

In a review of this nature the cases necessarily must be subdivided into certain groups. That any such subdivision is not wholly accurate is admitted, as the impression gained by one individual in reviewing a record may vary somewhat from that of another reviewing the same case. Even at the time of operation, there is an individual variation in the interpretation as to the extent of the pathology. This is not so evident in regard to the immediate pathology in the appendix, but is apparent in the diversity of opinion regarding the character of the exudate in the abdominal cavity. What is regarded as an infectious exudate by one surgeon may be called simply a protective exudate by another. In this review the presence of an exudate in the abdominal cavity, even though it be cloudy, is not considered as evidence of a peritonitis. Unless other criteria of peritonitis were present, this exudate has been considered a protective exudate.

The cases have been divided into four groups.

GROUP 1. *Acute Appendicitis, Uncomplicated*: This group includes those simple uncomplicated and nonruptured cases of acute inflammation.

GROUP 2. *Appendiceal Abscess*: If the case presented a definite and well localized abscess beyond the confines of the appendix it is included in this group.

GROUP 3. *Local Peritonitis*: In this group have been placed those cases in which there was obvious gross infection, beyond the confines of the appendix, which was not walled off, but was still quite well localized in the immediate region of the appendix and a spreading or diffuse peritonitis was not present.

MORTALITY OF ACUTE APPENDICITIS

GROUP 4. *Spreading Peritonitis*: All the advanced forms of peritonitis are included in this group.

Incidence and Mortality.—In Table I is summarized the incidence of the cases in the four pathologic groups and their mortality rates. The cases are divided into five year periods for comparative analysis.

TABLE I
INCIDENCE AND MORTALITY
In Five Year Periods

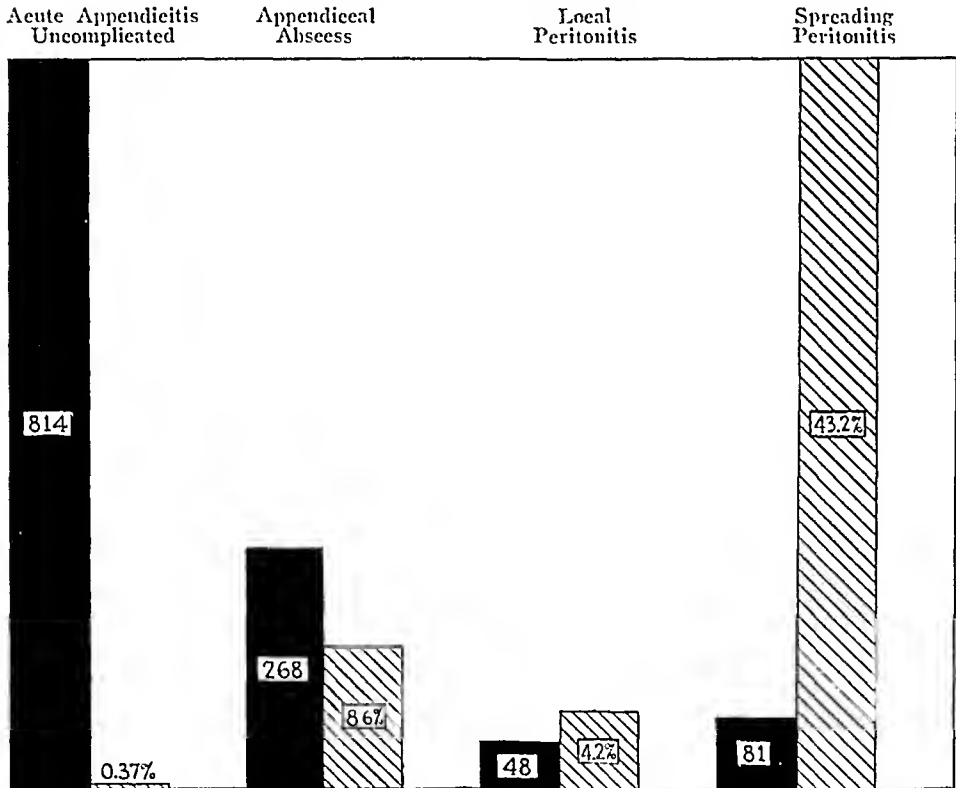
	Number Cases	Mortality	Total Mortality
1919-1924			
Acute appendicitis, uncomplicated	143 (68.4%)	0 — 0.0%	
Appendiceal abscess.	44	4 — 9.1%	
Local peritonitis.	10	0 — 0.0%	} 22%
Spreading peritonitis.	12	5 — 41.6%	
	209		4.3%
1924-1929			
Acute appendicitis, uncomplicated	172 (65.9%)	0 — 0.0%	
Appendiceal abscess.	52	4 — 7.7%	
Local peritonitis.	13	0 — 0.0%	} 29.7%
Spreading peritonitis.	24	11 — 45.8%	
	261		5.7%
1929-1934			
Acute appendicitis, uncomplicated	499 (67.3%)	3 — 0.6%	
Appendiceal abscess.	172	15 — 8.7%	
Local peritonitis.	25	2 — 8.0%	} 30%
Spreading peritonitis.	45	19 — 42.2%	
	741		5.3%
Total—15 Years			
Acute appendicitis, uncomplicated	814 (67.2%)	3 — 0.37%	
Appendiceal abscess.	268 (22.1%)	23 — 8.6%	
Local peritonitis.	48 (4.0%)	2 — 4.2%	} 28.7%
Spreading peritonitis.	81 (6.7%)	35 — 43.2%	
	1,211		5.2%

Although our total mortality rate is 5.2 per cent, that of the first five year period is 4.3 per cent, an appreciable difference—and yet the incidence of uncomplicated cases does not vary materially in the five year periods. There are two factors which may account for this lower mortality rate in the first five year period. First, in that period, because the surgical staff was small, there were fewer men operating upon these cases. In the past ten years the Junior Staff has been materially increased and the operative responsibility has been spread over a relatively larger group of surgeons. Secondly, there is the factor of the type of incision used. This point will be considered later, so for the present it will be sufficient to say that a McBurney incision was

used in a much higher percentage of the cases operated upon between the years 1919 and 1924.

The incidence in the different groups, however, remains fairly constant throughout the 15 years. The proportion of cases that were complicated on admission is extremely high, as approximately one out of every three had progressed beyond the uncomplicated stage.

GRAPH I
INCIDENCE AND MORTALITY
15 Years—1,211 Cases



Full black column—number of cases.
Black striped column—mortality in per cent.

Age and Mortality.—There is an unusually high mortality in the two extremes of life. In this series there were 200 patients under ten or over 50 years of age. This isolated group accounted for only 16.2 per cent of the total incidence, but 42.9 per cent of all deaths occurred in these patients (Graph 2).

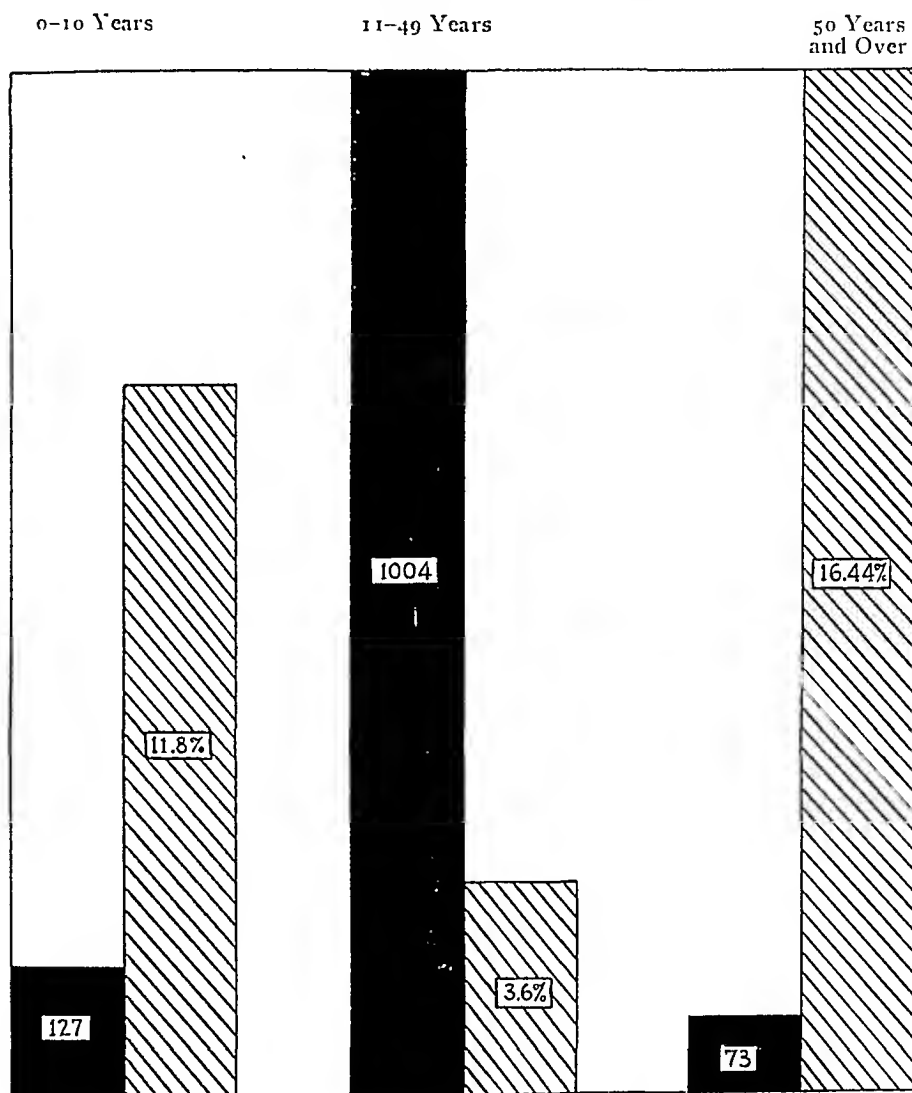
A very striking fact brought out in studying those patients over 50 years of age was the disproportion between the extreme severity of the pathologic change in the appendix and the relatively mild clinical picture presented. Of the 73 cases, only 27 were uncomplicated, while 36 had abscesses and 10 had a spreading peritonitis. Furthermore, of the 27 uncomplicated cases, gangrene or empyema was present in 18, and in several others a markedly inflamed organ was noted. Thus, of the 73 cases, 64 had either perforated or

in all likelihood would have gone on to perforation if operative intervention had not occurred.

That inflammation, once involving the appendix of older people, spreads rapidly, can also be shown. There were 36 patients seen within 50 hours

GRAPH 2

INCIDENCE AND MORTALITY IN THE EXTREMES OF LIFE



Seven cases. No age given.
Full black column—number of cases.
Black striped column—mortality in per cent.

after the onset of their symptoms, and 13 of these were complicated. In the remaining 23 patients, 17 had gangrene or empyema of the appendix. Even in the seven patients whose symptoms had been present under 12 hours, a gangrene or empyema was described in six.

The mortality rate for each group in these elderly patients was:

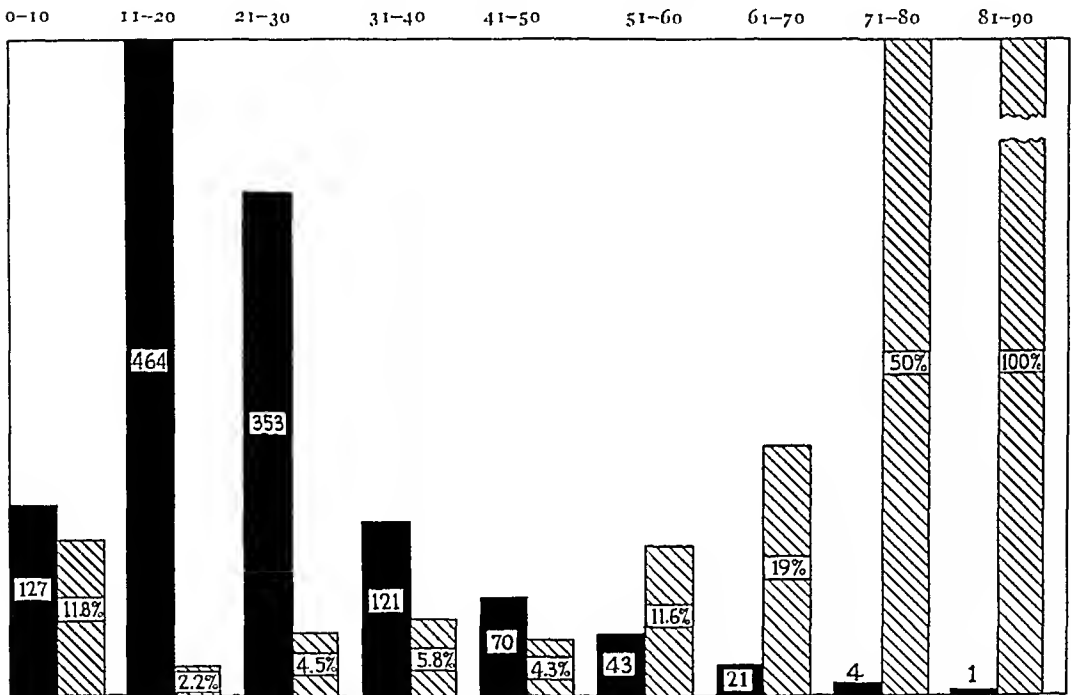
	Cases	Mortality
Acute appendicitis, uncomplicated.....	27	2 — 7.4%
Appendiceal abscess.....	36	7 — 19.4%
Spreading peritonitis.....	10	3 — 30.0%
Totals.....	73	12 — 16.4%

A critical study was also made in those patients six years of age and under. There were 38 patients in this group with six deaths—a mortality rate of 15.6 per cent. Three of the patients were two years old, six each were three, four and five years of age, and 17 were six years old.

One of the obstacles encountered in these children is the apparent inability or difficulty in making the diagnosis early. As evidence of this is the fact that 19 cases, or just one-half, had had their symptoms for over 72 hours by the time they were admitted to the hospital.

GRAPH 3

AGE INCIDENCE AND MORTALITY



Seven cases. No age given.
Full black column—number of patients in each decade.
Oblique striped column—mortality in each decade (per cent).

In all, pathologically, only 13 were uncomplicated, while 17 had abscesses and eight had a spreading peritonitis. Of the 17 patients with abscesses, all were operated upon (eight drained only) with no deaths. All six fatalities occurred in the eight children with spreading peritonitis. Two of these were moribund on admission and were not operated upon, and one was so ill that simply a drain was placed in the abdominal cavity (Graph 3).

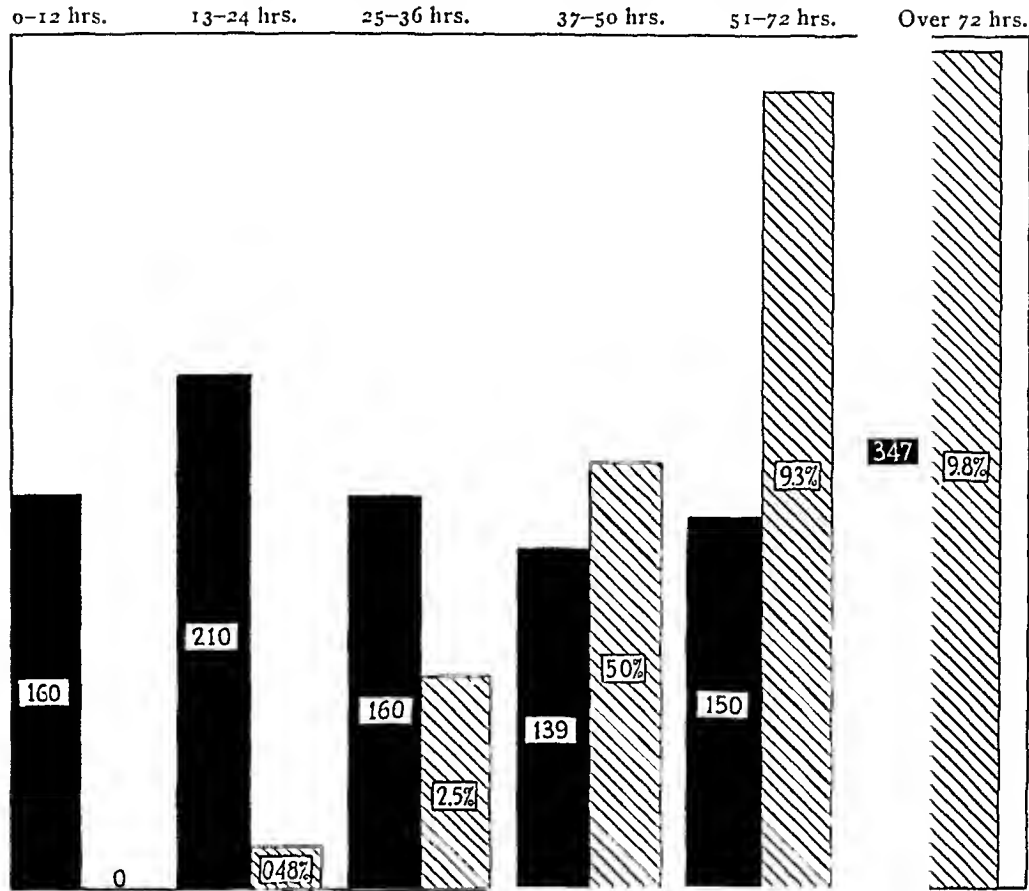
In the 38 cases, a history of previous attacks resembling the present one was obtained in five.

Sex and Mortality.—In this series, males predominated over females, the incidence being 59.7 to 40.3 per cent. The mortality rate for males was 5.4 to 4.9 per cent for females. This difference is explained by the fact that in females 26.8 per cent of the cases were complicated, while in males 36.7 per cent of the cases were complicated.

Duration of Symptoms and Mortality.—The correlation between the dura-

GRAPH 4

DURATION OF SYMPTOMS AND MORTALITY



Forty-five cases. No time given. Three deaths.
Full black column—number of patients in each period.
Oblique striped column—mortality in each period (per cent).

TABLE II

MOST FREQUENT ADDITIONAL DIAGNOSES

	Cases	Mortality
Pulmonary tuberculosis (tuberculous appendix—2).....	24	2
Inguinal hernia.....	10	1
Positive Wassermann reaction (tabes dorsalis—2).....	9	1
Pregnancy (one case aborted).....	9	
Diabetes mellitus.....	6	3
Acute upper respiratory infection.....	4	
Psychosis or mental deterioration.....	4	
Tuberculosis spondylitis.....	2	
Fracture.....	2	
Bronchiectasis.....	2	
Rheumatic heart disease.....	2	
Chronic pelvic inflammatory disease.....	2	
Chronic empyema cavity.....	2	
Residual paralysis of acute anterior poliomyelitis.....	2	
Osteo-arthritis.....	2	
Bronchopneumonia.....	2	2
Cardiovascular collapse.....	2	2

tion of symptoms and mortality presents an interesting study (Graph 4). Murphy's dictum, "The earlier the operation the lower the mortality," is at once apparent. Of the 347 cases (28.7 per cent) whose symptoms were present for over 72 hours, 211 were complicated, and the mortality for the whole group was 9.8 per cent. Of the 669 cases (57.4 per cent) in which the disease had been in progress less than 50 hours, there was a mortality rate of only 1.8 per cent.

GRAPH 5

DURATION OF SYMPTOMS AND PATHOLOGY

	0-12 hrs.	13-24 hrs.	25-36 hrs.	37-50 hrs.	51-72 hrs.	Over 72 hrs.
	157 Cases 20.1%	196 Cases 25.1%	131 Cases 16.7%	89 Cases 11.4%	73 Cases 9.3%	136 Cases 17.4%
Acute Appendicitis, Uncomplicated						
	0	5 Cases 1.9%	11 Cases 4.1%	31 Cases 11.7%	43 Cases 16.3%	174 Cases 65.9%
Appendiceal Abscess						
	1 Case 2.3%	6 Cases 13.6%	6 Cases 13.6%	9 Cases 20.5%	17 Cases 38.6%	5 Cases 11.4%
Local Peritonitis						
	2 Cases 2.6%	3 Cases 3.9%	12 Cases 15.8%	10 Cases 13.2%	17 Cases 22.4%	32 Cases 42.1%
Spreading Peritonitis						

Forty-five Cases. No time given. Three deaths.

In particular, note: (1) The high incidence of complicated cases before 50 hours. (2) The steady increase in cases developing spreading peritonitis. (3) Sudden drop of cases with local peritonitis after the seventy-second hour. (4) The high incidence of abscesses after the seventy-second hour. (5) The decline in uncomplicated cases after the twenty-fourth hour.

On the other hand, Graph 5 brings out one point which is not sufficiently stressed in the literature: that is, the high incidence of complicated cases developing before the disease is 50 hours old. In this series the number of complicated cases observed in each group before the disease had been in progress for 50 hours is, appendiceal abscess 17.8 per cent; local peritonitis 50.0 per cent, and spreading peritonitis 35.5 per cent.

Additional Diagnoses.—These accompanying conditions are listed in Table

II along with the mortalities that occurred with each disease. A few explanations must necessarily accompany this table.

In the 24 patients with pulmonary tuberculosis, two deaths occurred. At operation one of these patients had an appendiceal abscess and the other had a spreading peritonitis. It is of interest to note that, in the whole group, histologically, only two of the appendices which were removed showed evidence of tuberculosis.

In the one patient with an inguinal hernia who succumbed, the appendix had ruptured in the hernial sac with the formation of an abscess. This patient died of a diffuse peritonitis.

An associated diabetes mellitus exerted a profound influence in the prognosis in this series. There were six cases, and of these four were admitted with a spreading peritonitis. Death occurred in three of the four patients with spreading peritonitis.

Nine patients were admitted with pregnancies varying from four weeks to eight months. There were no maternal deaths and but one case aborted—with a fetal mortality. The pregnancy in this case was of six months' duration and a local peritonitis was found at operation. In one other case drainage of an appendiceal abscess was delayed until the day following delivery.

TABLE III
MOST FREQUENT IMMEDIATE COMPLICATIONS
In 1,148 Patients that Lived

Wound infection and cellulitis.....	67
Pelvic abscess.....	41
Acute follicular tonsilitis.....	17
Abscesses in R.L.Q. and L.L.Q.	11
Abscess site of hyperdermoclysis.....	10
Fecal fistula (two necessitated operation).....	9
Acute intestinal obstruction (one necessitated operation).....	9
Atelectasis (right side, 8 cases; left side, 1 case).....	9
Thrombophlebitis (left side, 7 cases; right side, 1 case).....	8
Pneumonia.....	7
Pulmonary infarct.....	6
Subdiaphragmatic abscess.....	2
Subhepatic abscess.....	2
Jaundice (probably from septicemia).....	2
Psychosis.....	2

TABLE IV
LATE SEQUELAE

<i>Acute Appendicitis — Uncomplicated</i>	
Acute intestinal obstruction (adhesions).....	5
One case had volvulus in addition (resected)	
Incisional hernia.....	1
	<hr/>
	6

TABLE IV—*Continued*

<i>Appendiceal Abscess</i>	
Reformed abscess.....	12
Acute intestinal obstruction (adhesions).....	2
Incisional hernia.....	2
Acute intestinal obstruction from reformed abscess.....	1
Incisional hernia and reformed abscess.....	1
Extraperitoneal abscess with draining sinus.....	1
Incisional hernia, residual abscess, appendico-sigmoid fistula.....	1
Acute appendicitis.....	1
Acute appendicitis with local peritonitis.....	1
	—
	22
<i>Local Peritonitis</i>	
Acute intestinal obstruction (adhesions).....	2
One treated conservatively.....	
<i>Spreading Peritonitis</i>	
Acute intestinal obstruction (adhesions).....	1
Acute intestinal obstruction from residual abscess.....	1
Draining sinus—sponge removed twenty-sixth day.....	1
	—
	3
One case of acute intestinal obstruction (in appendiceal abscess group) died.	

TABLE V

CAUSES OF DEATH

63 Cases

<i>Acute Appendicitis — Uncomplicated</i>	
Massive atelectasis.....	1
Bronchopneumonia.....	1
Diffuse peritonitis.....	1
	—
	3
<i>Appendiceal Abscess</i>	
Diffuse peritonitis.....	8
Bronchopneumonia.....	3
Bronchopneumonia and diffuse peritonitis.....	2
Septicemia.....	1
Septicemia and bronchopneumonia.....	1
Septicemia and diffuse peritonitis.....	1
Septicemia and multiple liver abscesses.....	1
Diffuse peritonitis and acute nephritis.....	1
Pulmonary embolus.....	1
Subdiaphragmatic abscess and acute empyema.....	1
Cardiac failure.....	1
Acute meningitis (<i>Staphylococcus aureus</i>).....	1
Acute meningitis, pneumonia and multiple liver abscesses.....	1
	—
	23
<i>Local Peritonitis</i>	
Diffuse peritonitis.....	1
Diffuse peritonitis and septicemia.....	1
	—
	2

TABLE V—Continued

Spreading Peritonitis

Diffuse peritonitis.....	21
Diffuse peritonitis and septicemia.....	7
Diffuse peritonitis and bronchopneumonia.....	2
Diffuse peritonitis and pulmonary edema.....	2
Diffuse peritonitis, septicemia and bronchopneumonia.....	1
Spinal anesthesia (peritonitis five days—died on table).....	1

35

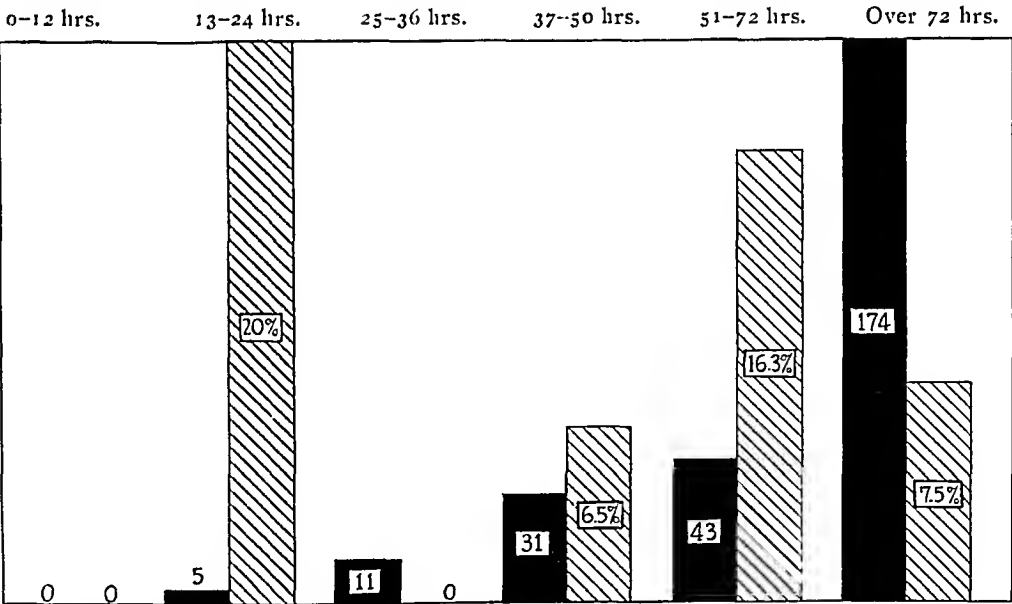
Previous Attacks.—A high incidence of a history of previous attacks was observed in this series. However, the mortality rate in this isolated group was quite low. The incidence and mortality were:

	Incidence	Mortality
Acute appendicitis, uncomplicated.....	45.7%	0
Appendiceal abscess.....	33.2%	6.7%
Local peritonitis.....	33.3%	0
Spreading peritonitis.....	14.8%	41.7%
Total—1,211 patients.....		2.2%

Appendiceal Abscess.—A study of the cases with appendiceal abscesses is epitomized in Graph 6. The mortality rate was 8.6 per cent. Of particular significance is the high mortality rate when these patients were operated

GRAPH 6

APPENDICEAL ABSCESS. DURATION OF SYMPTOMS AND MORTALITY IN 268 CASES



Full black column—number of cases. Black striped column—mortality in per cent. Four cases. No time given. No deaths.

Type of operation.	Cases	Mortality
Drainage and ectomy.....	147—54.8%	14—9.5%
Drainage alone.....	121—45.2%	9—7.4%

upon in that period from 50 to 72 hours after the onset of symptoms. This high rate dropped materially when operation was delayed. The drop in the

mortality rate can be explained rationally on the more adequate walling off that undoubtedly obtains as time progresses. This has led to a change of policy in our treatment of appendiceal abscesses so that now, if an abscess can be diagnosed definitely, operation is delayed until a period when adequate walling off has occurred. Also, we feel that it is advisable to use a McBurney incision for this procedure unless there is some definite contra-indication.

Type of Incision.—A study of the type of incision used and the associated mortality reveals some facts worthy of consideration. Either a right rectus or McBurney incision was used in all but 30 cases. Three of these 30 did not undergo operation.

In using a right rectus incision the mortality rate was:

	Cases	Mortality
Acute appendicitis, uncomplicated.....	514	3 — 0.6%
Appendiceal abscess.....	207	19 — 9.7%
Local peritonitis.....	42	2 — 4.8%
Spreading peritonitis.....	74	30 — 40.5%
Totals.....	837 — 67.5%	54 — 6.4%

The mortality rate for the McBurney incision was:

	Cases	Mortality
Acute appendicitis, uncomplicated.....	294	0
Appendiceal abscess.....	43	1 — 2.3%
Local peritonitis.....	6	0
Spreading peritonitis.....	1	1 — 100.0%
Totals.....	344 — 28.4%	2 — 0.6%

There is a striking difference in these rates which especially is noted in the complicated cases. However, the McBurney incision was not used in a sufficient number of the complicated cases to make the analysis of accurate statistical value, although the marked difference in the two groups cannot be passed over lightly.

In the first five years included in this study the McBurney incision was used in 50.7 per cent of the cases in contradistinction to 20.8 per cent in the last five years. In all probability this is a major factor in the lower mortality rate of the first five year period.

That exploration is limited with the use of a McBurney incision is indicated by the fact that of the appendiceal abscesses operated upon through a McBurney incision the appendix was removed in only 16 cases.

Miscellaneous.—Chills occurred in 3.1 per cent of these cases preoperatively. All of these were single chills. That they are of little value prognostically is indicated by the comparable incidence in each group, *i. e.*:

Acute appendicitis, uncomplicated.....	3.1%
Appendiceal abscess.....	3.4%
Local peritonitis.....	4.2%
Spreading peritonitis.....	2.5%

All of these patients with single preoperative chills recovered.

Two cases had multiple chills postoperatively. One died and a pyelephlebitis with liver abscesses was found at autopsy. The other case clinically had pyelephlebitis but recovered.

Intestinal parasites were recovered in 11 of the appendices. For the most part a mild inflammation was present and no deaths occurred. The oxyuris vermicularis was present in nine cases and the ascaris lumbricoides in two.

An adenocarcinoma (carcinoid tumor) was found in addition to the inflammation in two cases. One case was uncomplicated and the other had a local peritonitis. Both recovered.

DISCUSSION.—At the present time the foremost controversial question involving acute appendicitis is whether to treat those cases with a spreading peritonitis conservatively until localization occurs or to operate immediately. After studying this group of patients and those series in which conservative therapy has been used we are unable to conclude that either method is so satisfactory that it can be employed to the total disregard of the other. We feel that the treatment should be individualized to suit the patient rather than to lay down any dogmatic rule.

If the patient is seen relatively early after perforation we know that the result of operative treatment is satisfactory, as evidenced by the low mortality rate in that group with local peritonitis. Also, there are many patients in whom a perforation is suspected clinically but at the time of operation the pathology is uncomplicated. In all probability this is the situation in many of those cases treated conservatively for a peritonitis in whom an abscess never forms.

We feel that even in those cases with an advanced peritonitis immediate operation is indicated as long as the patient is in good condition, thereby eliminating the focus of the infection. The argument is advanced that operation traumatizes the peritoneum before immunity is established, and this is deleterious. Even if this were so the operation can be done with a minimal degree of trauma by using a McBurney incision and spinal anesthesia, and by handling all of the tissues with extreme gentleness.

For the most part, conservative treatment in those cases with a spreading peritonitis, is relegated to patients who are in any degree of shock or who are moribund on admission. The only other group of patients whom we believe should be treated conservatively on admission is that group with appendiceal abscesses whose symptoms have been present for less than 72 hours. In this group the abscesses are not adequately walled off to warrant operative manipulation.

CONCLUSIONS

(1) A cloudy exudate in the peritoneal cavity is oftentimes considered as evidence of peritonitis when in reality it is a protective exudate.

(2) The total mortality rate for acute appendicitis in this hospital is 5.2 per cent.

(3) The mortality rate has increased approximately 1.0 per cent in the past ten years, in all probability as a result of an increase in the number of surgeons operating and the more frequent use of a right rectus incision.

(4) Over two-fifths of all deaths occur in those patients in the two extremes of life.

(5) Murphy's dictum, "The earlier the operation the lower the mortality," is aptly illustrated.

(6) An accompanying diabetes mellitus exerts a profound influence on the prognosis in acute appendicitis.

(7) The mortality rate for appendiceal abscesses is 8.6 per cent. From the results of this study we feel that operation upon these patients should be delayed until adequate walling off has obtained.

(8) Unless there is some definite contraindication, a McBurney incision is recommended for both uncomplicated and complicated cases.

(9) Single preoperative chills are of no prognostic value.

(10) The treatment of cases with a spreading peritonitis should be individualized. For the most part we prefer the operative treatment in these patients unless they show evidence of shock.

THE TREATMENT OF GASEOUS DISTENTION OF THE INTESTINE BY THE INHALATION OF NINETY-FIVE PER CENT OXYGEN*

DESCRIPTION OF AN APPARATUS FOR THE CLINICAL ADMINISTRATION OF
HIGH OXYGEN MIXTURES

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THE purpose of this communication is to describe a method for the treatment of intractable distention of the small intestine by the inhalation of 95 per cent oxygen. The principle underlying the use of this agent is based on recent studies in animals^{1, 2, 3} which demonstrated, (1) that nitrogen and hydrogen are the major constituents of the gases causing distention, and (2) that the inhalation of pure oxygen effects a substantial reduction in the gas volume of the obstructed small intestine inflated with these gases.

The inhalation of pure oxygen accomplishes this result by preventing the entrance of atmospheric nitrogen into the lungs. The nitrogen in the blood and tissues is consequently rapidly exhaled (60 per cent within one hour).⁴ The resulting fall in the partial pressure of this gas in the blood not only prevents its diffusion from the blood into the intestine but at the same time accelerates its diffusion from the intestine into the blood. Our experiments showed that after the inhalation of pure oxygen for 24 hours the volume of nitrogen originally injected into the small intestine obstructed at the pylorus and ileocecal valve was reduced approximately 62 per cent in comparison with an absorption of some 10 per cent when air is breathed.

When the small intestine was inflated with hydrogen, the residual gas volume was likewise found to be considerably smaller in an animal breathing oxygen than in one breathing air, although the difference between the two was not nearly so great as in the case of nitrogen. The beneficial effects of oxygen on the intestine distended with hydrogen were found to be due not to any increase in the rate of diffusion of hydrogen from the intestine into the blood, but to the fact that the nitrogen which ordinarily diffuses into the intestine in considerable quantity from the blood has been eliminated and is not available during the period of oxygen inhalation.

The decompressing action of oxygen was however shown to be ineffective for the distended stomach, apparently because the surface area available for absorption is very much less than that of the small intestine.³ Since the

* The expenses of this investigation were provided by the DeLamar Mobile Research Fund, Harvard Medical School.

stomach, like the unobstructed colon, can be readily deflated by a rubber tube, oxygen should find its usefulness restricted primarily to distention of the small intestine.

It is clear from the foregoing that the closer to 100 per cent the concentration of inspired oxygen the more effective it should be in decreasing the volume of distending gases. In animals 70 per cent oxygen does not reduce the gas volume sufficiently to be of practical value. The oxygen tents in current use do not provide a concentration higher than 70 per cent even with an extravagant supply of oxygen. We have therefore constructed a modified Barach tent (Figs. 1 and 2) which will yield an oxygen concentration of at least 95 per cent for the treatment of obstinate distention.*

The essential change consists in replacing the ordinary tent by a small rubberized canvas helmet, the bottom of which is closed by a very soft pliable rubber diaphragm with a circular defect (diameter three inches) to accommodate the patient's neck snugly and without discomfort. A closed circuit is thereby created which is sufficiently tight and small in volume so that a concentration of oxygen of about 95 per cent or over is rapidly attained.

To reach this percentage it is, of course, necessary to eliminate the room air present in the system as well as the nitrogen exhaled by the patient. All of the lung nitrogen is removed within the first three to five minutes of pure oxygen administration.⁴ At the outset, oxygen is delivered at the rate of 12 liters per minute. By means of a two-way valve on the delivery side of the circuit the system is washed out for about 20 seconds several times during the first 15 minutes. During this washing-out period the hood, except for its rigid roof, collapses gently about the patient's head; but upon closure of the valve the hood reinflates rapidly. Following these preliminary maneuvers the rate of flow of oxygen is reduced to from four to five liters per minute. Gas samples obtained from a sampling jet on the return side of the circuit show oxygen percentages varying from 92 to 98 per cent within 15 to 20 minutes after starting. Now and then during the course of the administration of oxygen the apparatus is washed out and replaced by pure oxygen in order to get rid of the small amounts of nitrogen which continue to be eliminated from the blood, tissues and intestine.

The hood is suspended over the patient's head and can be accommodated to any position, although the sitting position is most convenient. Such a hood provides ample elasticity and volume to permit full respiratory excursions without the restricted feeling one experiences in the rigid helmet devised by Benedict⁵ for short periods of administration of pure oxygen. In contrast to the ordinary tent, the subject's body is accessible for nursing purposes and for physical examination of the chest, without losing the benefits of oxygen therapy during these manipulations. Subjectively there is an absence of the imprisoned feeling of the ordinary tent which is objectionable to many

* The details of the apparatus were worked out in collaboration with the Warren E. Collins Company of Boston, who constructed the machine as illustrated.

patients. Three celluloid windows provide for ample vision and patients can hear and be heard readily without having to open the tent. A sleeve is provided below the front window for feeding purposes, but it is much simpler

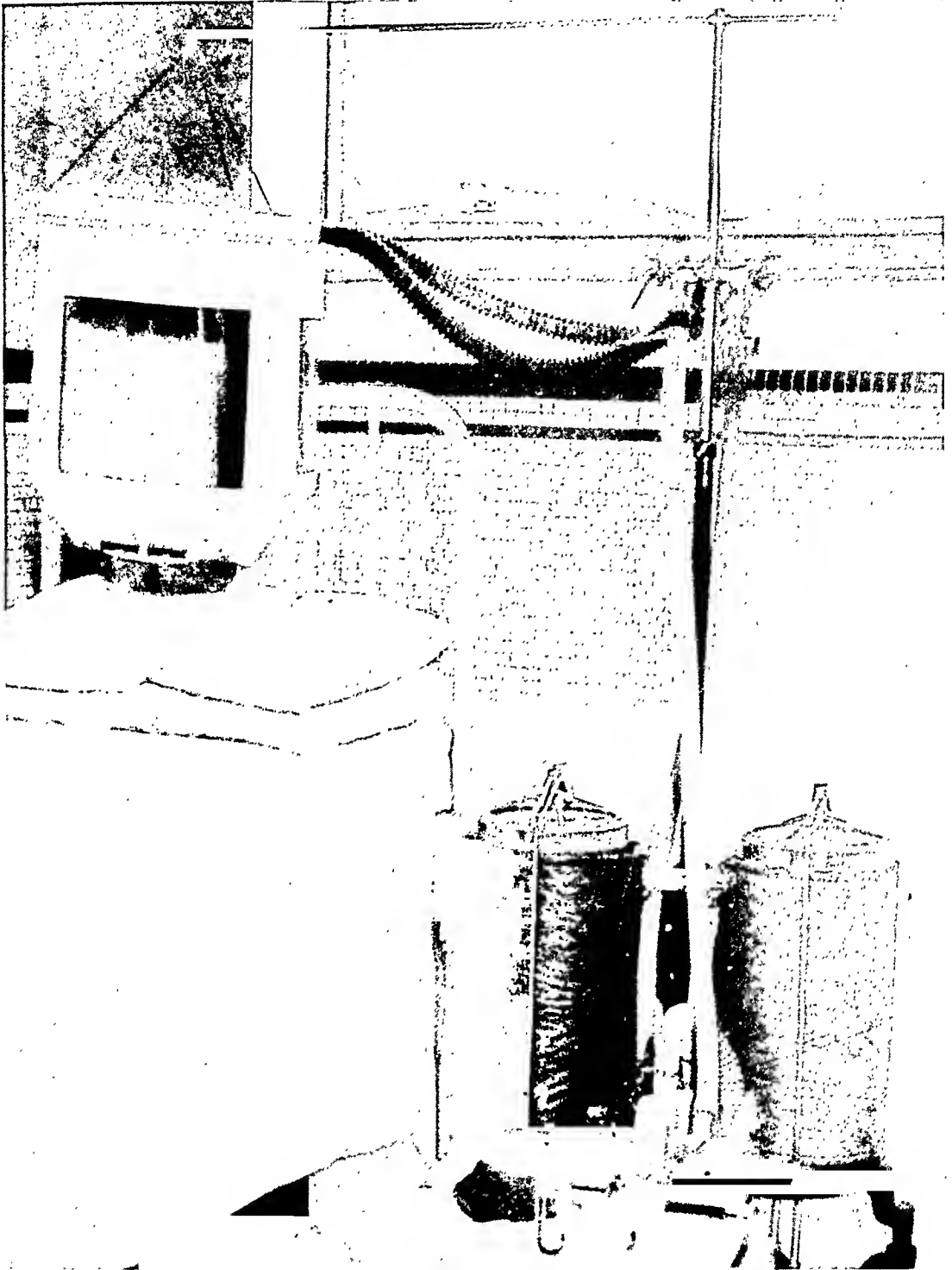


FIG. 1.—Photograph of apparatus for the clinical administration of 95 per cent oxygen.

to deliver food and drink through the opening in the diaphragm around the neck. The resulting inflow of room air is not a serious disadvantage because the entire system can be washed out and pure oxygen replaced within a few minutes.

The rest of the unit is mounted on the same stand as the hood and consists of a motor blower which sucks the air out of the hood and then drives it through two insulated cans filled with ice. One of the cans also contains a tray of soda lime for absorption of CO_2 . The air together with additional oxygen from the tank is then delivered through a flattened slit-mouthed nozzle into the hood and is directed downward in front of the subject's face. It is then sucked back through a perforated tube in the top of

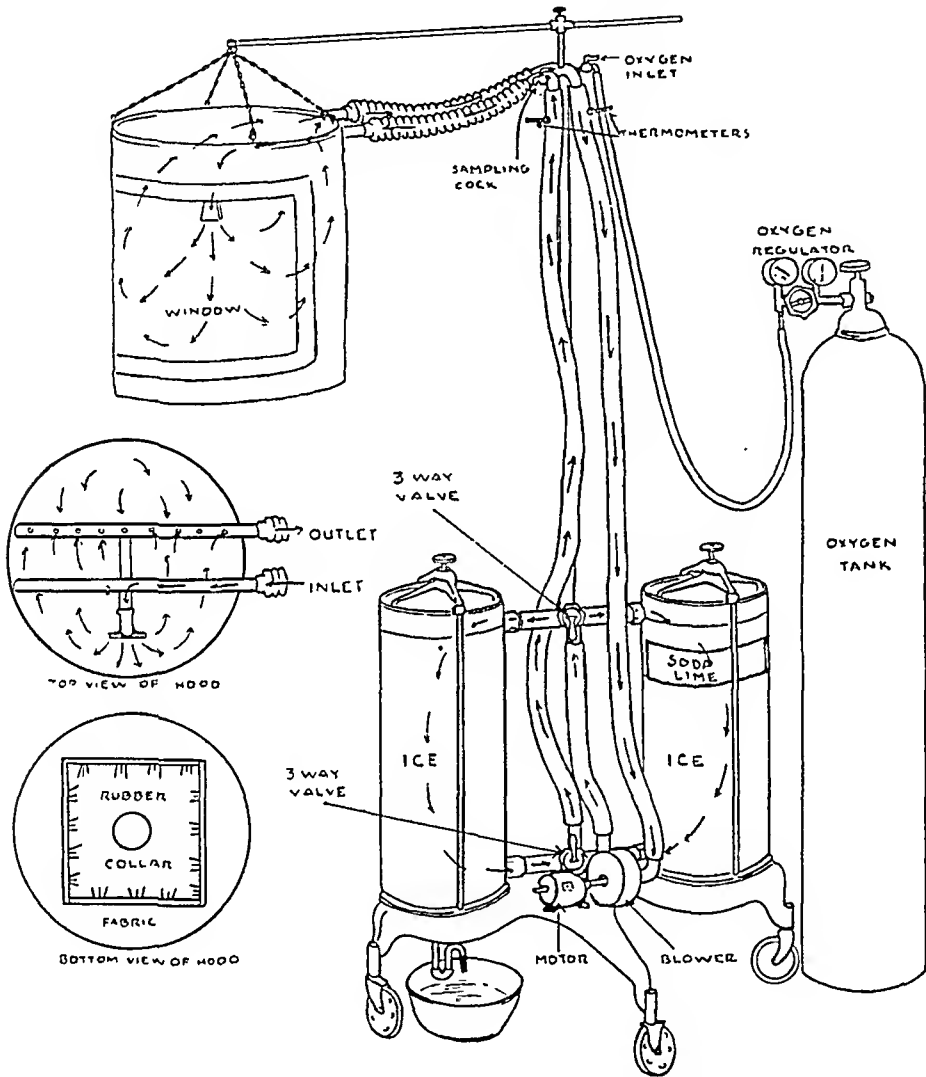


FIG. 2.—Diagrammatic sketch of apparatus for the clinical administration of 95 per cent oxygen.

the hood. Thermometers on the intake and return tubes afford a measure of the cooling efficiency of the system. With a normal human subject in the helmet and a room temperature of 24°C the oxygen enters the hood at a temperature of 15°C to 16°C . When the cooling is inadequate the temperature difference lessens, thus indicating the need for ice replacement. Either ice-can may be refilled, without interrupting the oxygen flow, by shunting the can to be filled out of the circuit by means of valves which

direct the gas flow through both cans or either one, as desired. Water drains out of the bottom of either can through a siphon outlet common to both. A resistance box on the stand controls the intensity of the blast from the blower to meet the subject's preference as to ventilating speed. If for any reason the helmet becomes uncomfortable it can be readily removed, even by the patient. The operating cost of this apparatus is less than that of the ordinary tent because of the smaller volume of oxygen necessary to maintain the desired concentration.

The reduction of the gas volume in the small intestine of animals obtained by this apparatus* compares favorably with the results in previous experiments³ in which commercially pure oxygen was supplied by a tracheal cannula. Thus the decrease in gas volume in the small intestine by the tracheal cannula method averaged 40 per cent after 12 hours and 57.5 per cent after 24 hours. With this apparatus the results in two 12-hour experiments were 60 and 66 per cent and in two 24-hour experiments 63 and 70 per cent.

Due cognizance must be taken of the toxic properties of high concentrations of oxygen before submitting patients to this agent. We shall deal with this aspect of the subject more fully in a subsequent clinical report. In passing it may be worth summarizing briefly what data is at hand in this connection. Animals can breathe 70 per cent oxygen indefinitely, but higher concentrations eventually produce pulmonary edema. No apparent harm however results from pure oxygen if given to animals for 16 out of every 24 hours for many days.⁶ Healthy men can breathe pure oxygen for at least four hours without toxic symptoms.⁴ Sayres⁷ has exposed men to 100 per cent oxygen for eight hours continuously with impunity. Evans and Dushordwe⁸ state that they have given pure oxygen to patients with cardiac or pulmonary disease for 24 hours or longer with nothing but benefit. Since they employ a mask and allow feeding at the same time it may be doubted that the patients receive pure oxygen continuously.

Our clinical experience to date with the use of the apparatus described above is limited to five cases.

CASE REPORTS

CASE I.—A male, aged 65, entered the hospital complaining of generalized abdominal pain of three days' duration. The history was altogether unreliable owing to the confused mental status of the patient. For two years he had been troubled with nocturia and straining during micturition. In spite of repeated enemata he had passed no flatus during the last 24 hours. For the past 12 hours he had vomited a dark brown fluid repeatedly.

Physical examination revealed a dehydrated male with peripheral vascular collapse. The abdomen was severely distended, tense, generally tender, tympanitic everywhere except for dulness to percussion in the flanks and lower abdomen. A fluid wave was present. Red blood cell count 3,600,000, hemoglobin, 70 per cent (T), white blood cell count 20,300, blood nonprotein nitrogen 109, blood chlorides 446. A roentgenologic interpretation of a flat film of the abdomen was as follows: "The small bowel, especially in the left upper quadrant appears distended and shows numerous fluid levels. There is also some disten-

* In the animal experiments we used instead of the helmet a water sealed box supplied with a water valve to allow the escape of excess gas.

tion of the large bowel." Immediate laparotomy through a lower right rectus incision revealed a generalized peritonitis with large quantities of free fluid. In the field of operation the intestine was not distended. Immediately after operation the patient was placed in the helmet and he breathed 95 per cent oxygen until his death 14 hours after operation.

Autopsy revealed an obstructing median lobe of the prostate with a ruptured diverticulum in the dome of the bladder, and generalized peritonitis with over a liter of purulent fluid. Fibrous adhesions were found everywhere among the organs in the peritoneal cavity but there was no evidence of mechanical obstruction. *The entire small intestine was collapsed and contained no gas.* There was no edema, atelectasis or consolidation of the lungs, but there was slight congestion of both bases. The bronchial tree contained a small amount of secretion but no blood. The pulmonary vessels were normal. Microscopic examination of the lungs showed no hemorrhagic extravasation. The alveolar walls were not thickened. A few arterioles contained red cells in clumps resembling small thrombi. The rest of the autopsy was irrelevant.

COMMENT.—These findings indicate that there was no damage to the lungs as a result of 14 hours of continuous oxygen inhalation. The evidence in this instance as to the influence of pure oxygen inhalations on the degree of distention is somewhat equivocal, but it is certainly unusual to find the entire small intestine collapsed in cases of generalized peritonitis.

CASE II.—A male, aged 72, was admitted to the hospital with a diagnosis of coronary thrombosis, three weeks after the onset of severe chest pain associated with paroxysmal nocturnal dyspnea, weakness and fever. For four days preceding entry there had been no bowel evacuation. On admission the patient was slightly cyanotic, had a blood pressure of 110/90 and was moderately distended. There were moist râles at the bases of both lungs and he was thought to be developing a bronchopneumonia. The distention increased in spite of enemata, dry heat and turpentine stupes to the abdomen. There was occasional peristalsis but without appreciable expulsion of flatus. Two days after admission the patient was placed in the helmet and 95 per cent oxygen administered for a period of nine and one-half hours with a one-half hour interval outside the helmet.

During the period of oxygen administration the cyanosis disappeared, the pulse was slowed from 92 to 82, the blood pressure remained essentially the same, and the white blood cell count fluctuated from 11,000 to 13,000. *The abdominal girth measurements decreased some six cm.* Flatus was expelled in small amounts from time to time. Three hours after the oxygen was stopped the patient deflated spontaneously and the girth of the abdomen decreased to nearly normal. The patient remained comfortable and the lungs cleared up entirely in the next few days. Five days later the distention recurred but was relieved by ordinary procedures. The patient left the hospital much improved 17 days after entry.

COMMENT.—In brief, this case is one in which a patient with acute coronary disease breathed 95 per cent oxygen for nine hours with no demonstrable deleterious effect. It is by no means conclusive of the value of 95 per cent oxygen for intestinal distention inasmuch as the greater degree of deflation occurred several hours after stopping the inhalation of oxygen. But it is not unreasonable to assume that a severely distended intestine, incapable of peristaltic activity by virtue of the overstretching of its muscle, may be restored to effective peristaltic activity by decreasing its gas volume sufficiently to enable the muscle to recover its tone. Thus it is possible that the oxygen inhalation, having facilitated a significant absorption of nitrogen

via the blood (as evidenced by the six cm. decrease in abdominal girth), made it possible for the intestine to recover its tone and so to complete its deflation. Additional evidence in favor of this assumption is given in the following case history.

CASE III.—A girl, aged six, 72 hours before admission had a severe chill followed by intermittent fever, anorexia, constipation, and oliguria. She had recently recovered from a cold. Shortly before entry she vomited and began to have diarrhea with rectal tenesmus. On admission the child was extremely toxic and pale and was complaining of generalized abdominal pain.

Physical examination was not remarkable except for the abdomen which showed a board-like rigidity and diffuse tenderness, especially in both lower quadrants. The temperature fluctuated between 101°F and 105°F, the pulse from 120 to 140, and the respirations 20. The urine was negative, the red blood cell count was 3,250,000, hemoglobin 65 per cent (T) and the white blood cell count was 22,500 with a differential of 88 per cent polymorphonuclear leukocytes, of which 16 per cent were band forms. Blood and stool cultures were negative. For six days the patient continued to have diarrhea. The abdomen would alternately soften and become rigid. In spite of the fact that she passed flatus freely the abdomen gradually became more distended. On the sixth day after entry the child was slightly cyanotic, respirations became labored and the abdominal distention and rigidity increased. She was put into the helmet and 95 per cent oxygen administered. The following table gives the measurements of the abdominal girth at three levels before, during and after the period of oxygen therapy (Table I).

TABLE I
Abdominal Girth in Centimeters

Date	Hour	At costal mar- gin	At um- bilicus	Halfway between umbili- cus and symphysis pubis	Remarks
March 22, '35	5:30 P.M.	66	63.5	64.5	{ No flatus passed during this pe- riod.
	5:30 P.M.	Oxygen helmet applied *			
	8:30 P.M.	64	64	62	
	11:30 P.M.	63	61.5	61	
March 23, '35	2:30 A.M.	63	61	59.5	2:25 Expelled large amount of flatus.
					3:15 Expelled large amount of flatus and had large stool.
					3:25 Expelled large amount of flatus.
					4:30 Expelling flatus freely.
	5:30 A.M.	61	59	58	
	8:30 A.M.	61	59	58	
	11:30 A.M.	61	60	59	11:30 Abdomen much less dis- tended though not soft.
	2:30 P.M.	60	59	58	
	6:00 P.M.	Oxygen discontinued			
March 24, '35	7:30 A.M.	61	59.5	58	
	5:30 P.M.	63	61	59	
March 25, '35	7:30 A.M.	60.5	59	57	

* From 5:30 P.M. March 22 to 6 P.M. March 23 the helmet was removed every four to six hours for about one-half hour. Total time of exposure to 95 per cent oxygen was 20 hours.

During the period in the helmet the pulse dropped from 130 to about 110, an effect commonly observed when high oxygen mixtures are breathed. The cyanosis disappeared. Shaw and Behnke⁴ have noticed an occasional instance of an increase in the white blood cell count, but none occurred in this instance.

The child proceeded to improve rapidly within the next 24 hours and distention did not recur. The diarrhea stopped. Three days later she was well on the road to recovery. At present she shows some induration in the pouch of Douglas and seems to be localizing a small pelvic abscess. The abdomen is flat, and not tender; the appetite and bowel function are practically normal.

COMMENT.—In this patient moderate distention had been present from the time of entry until 36 hours preceding oxygen administration when it became severe. Throughout this period the child had been expelling flatus now and then in small amounts but not sufficient to prevent increasing distention. It will be noted in Table I that for the first eight hours of oxygen inhalation no flatus was expelled per rectum or regurgitated by mouth, but the abdominal girth was substantially reduced. After this, there were frequent discharges of large amounts of flatus so that an effective decompression of the intestine occurred within 15 hours after beginning the oxygen inhalation. Presumably the oxygen had accomplished sufficient shrinking of the bowel by the absorption of nitrogen via the blood so that the intestine (which was undoubtedly in an irritable state as evidenced by the severe diarrhea) was able to complete the deflation by peristalsis.

The prompt and complete recovery which followed almost immediately after 20 hours of breathing 95 per cent oxygen without subjective or objective signs of damage to the brain or lungs constitutes evidence that either the toxic properties of high concentrations of oxygen do not assert themselves until after such an interval or that they can be minimized or avoided by intermittent administration.

In the animal experiments already referred to it was noted that a substantial decrease amounting to over 40 per cent of the initial distending volume was observed after 12 hours of intermittent oxygen administration. In the preceding case a significant decrease was noted within eight hours. In the following case an appreciable decrease was observed within six hours. During this time there was no belching or discharge of flatus by rectum so that the shrinkage in distending volume can be attributed to increased absorption via the blood as a result of the use of oxygen.

CASE IV.—A male, aged 46, house painter by occupation, entered the hospital complaining of generalized abdominal pain and constipation of three days' duration. The pain was characteristic of intestinal colic and had been associated with much retching and occasional vomiting. For three days, in spite of repeated enemata and magnesium sulphate by mouth, he had passed nothing by rectum and gradually became markedly distended. Examination on admission revealed nothing remarkable except pulmonary emphysema and a distended abdomen which was tympanitic throughout to percussion. There was no audible peristalsis. He was suspected of having lead colic. The urine was found to contain lead. Pending a roentgenologic study of the colon the following morning to rule out a large bowel obstruction, he was given 95 per cent oxygen by the helmet (Table II).

GASEOUS INTESTINAL DISTENTION

TABLE II

Time	Conc. of O ₂ in the helmet	Pulse rate	Blood pressure	White blood cell count	Circumference of abdomen in cm. at		
					Costal margin	Um-bilicus	Midway between umb. and symph. pubis
10:40 P.M.	Oxygen started						
10:40 P.M.	90%	76	170/120	10,000	95.5	97.25	95.5
11:30 P.M.	94	76	140/86	..	93.0	98.0	96.5
1:30 A.M.	92	88	160/90	..	95.0	96.0	94.5
2:30 A.M.	99	88	140/90	18,950	93.0	96.0	95.0
4:30 A.M.	98	76	130/86	..	92.0	95.5	92.
7:30 A.M.	94	80	140/90	15,800	92.0	95.	91.0
8:30 A.M.	Oxygen discontinued						
9:30 A.M.	Barium enema; roentgenologic findings negative.						

The patient was by no means completely relieved of distention after ten hours of oxygen therapy, but there was no doubt that the abdomen had been considerably reduced in size within six hours and that distention had been considerably relieved in spite of the fact that no gas was passed by rectum during this period. Oxygen was discontinued during the following day until evening when after another six hours in the helmet an enema resulted in practically complete deflation.

CASE V.—A girl of seven was admitted with bilateral bronchopneumonia and empyema due to a streptococcus infection. She was extremely dyspneic and cyanotic on admission and seemed almost moribund. The abdomen was markedly distended. She was placed in a Barach-Collins oxygen tent for 24 hours but the cyanosis did not appear. Because of this and because there was a well marked abdominal distention which did not yield to hot stupes and enemata she was given 95 per cent oxygen by the helmet. The cyanosis was replaced by a pink color in the lips and fingers. Without removing the helmet she was placed on her side and a left trocar thoracotomy was done. During the following six hours the pulse dropped from 170 to 156, but the respiratory rate remained unchanged at 68. Oxygen was continued for 15 hours, with three interruptions outside of the helmet for periods of 30, ten and five minutes. At the end of this time she expelled a large amount of flatus and the abdomen became soft.

Oxygen was continued, with occasional interruptions totalling two hours, for the next eight hours because intense cyanosis returned as soon as she was removed from the helmet. The following day mild distention recurred, but for the preceding 12 hours she had refused to stay in the helmet except for periods too short to be effective for deflation purposes. The pulse had meanwhile dropped to an average of 140, and the white blood cell count fell from 38,000 to 18,400. These changes were in all probability due to surgical drainage of the left pleural cavity. A right trocar thoracotomy was then done. The child in the course of the subsequent six weeks improved very considerably and is now in the convalescent stage.

COMMENT.—In this patient the dangerously low vital capacity due to the pulmonary infection was threatened still more by abdominal distention. The ordinary oxygen tent had failed to relieve the cyanosis and the usual measures for the relief of the distention had likewise proved ineffective. By the use

of 95 per cent oxygen the cyanosis was dispelled and, as in Cases II and III, an adequate deflation of the intestine was accomplished.

It is impossible to affirm or deny the occurrence of toxic effects of 95 per cent oxygen in this child. However, the pulmonary edema or hemorrhage and the cerebral effects attributable to oxygen poisoning were not observed.

DISCUSSION.—There are a few recorded observations on the effect of 95 per cent oxygen on abdominal distention. Thus Evans and Dushordwe⁸ incidentally observed that their pneumonia patients who were given pure oxygen by nasal catheter were relieved of their distention within 36 to 48 hours. They assume that anoxemia causes distention and that the relief of the anoxemia restores intestinal muscle tonus with resulting deflation. By this hypothesis oxygen must be considered only indirectly responsible for the relief of the distention and of value only in virtue of the existence of anoxemia.

W. T. McConnell and R. L. McCormack⁹ report 16 cases of distention following cesarean section which were relieved by 95 per cent oxygen and five per cent carbon dioxide. They state that "the distention is due to shock, paralysis of the splanchnic nervous system, loss of smooth muscle tone and decrease in local circulation. An increase in carbon dioxide tension has long been known to stimulate smooth muscle activity. Therefore, one would expect the administration of carbon dioxide and oxygen to stimulate peristalsis and restore normal cellular function." Apparently the authors considered carbon dioxide the chief agent responsible for the relief of the distention, but it is not clear what rôle 95 per cent oxygen played. When one notes further that they used this gas mixture three or four times for five-minute periods every three to four hours, it is difficult to see how the use of 95 per cent oxygen for a total of some 20 minutes in all could have had any important bearing on the results observed.

We have already referred to the experimental evidence showing that the inhalation of 95 per cent oxygen causes a much more rapid deflation of distended intestine than occurs when air is breathed. Since this observation was made on the mechanically obstructed intestine the favorable effect of oxygen in these experiments cannot be attributed to the possible effect of oxygen on muscle tonus except insofar as increased muscle tonus results in increased intra-intestinal pressure with resulting increase in the speed of absorption of intestinal gases. That this can be of nothing more than minor significance however is clear from the evidence we have presented in a previous report.³ In the unobstructed intestine it is not safe to assume that oxygen aids in the deflation by an effect on muscle tonus until well controlled observations showing such an effect are available.

The oxygen saturation of the blood has little or nothing to do with the effect of breathing pure oxygen on gaseous distention of the intestine. Our experimental observations demonstrate that the effect of oxygen depends primarily on the laws governing gaseous exchange across a semipermeable

membrane and lies in the fact that *by excluding nitrogen from the inspired air*, the nitrogen in the blood and tissues is exhaled and in consequence the nitrogen in the intestine diffuses out of the intestine into the blood much more rapidly than occurs when air is breathed. At the same time nitrogen which ordinarily diffuses from the blood into a distended intestine in large quantities is no longer available for this purpose.

That this mechanism operates in man is apparent from Cases III and IV in which a sizable decrease in abdominal girth was observed after a number of hours of inhalation of 95 per cent oxygen and *before any gas was passed by rectum*. None of the patients included in this report were victims of mechanical obstruction and all of them eventually completed the deflation spontaneously. Their failure to do so for several days preceding the administration of oxygen with all the usual measures for the treatment of distention suggests that the oxygen permitted the unobstructed but overstretched intestine to recover effective peristaltic activity simply by accomplishing a partial shrinking of the bowel lumen.

One may infer that the deflation attributed to oxygen in the five patients reported might well have occurred without its use. This cannot be denied. On the other hand the fact that the distention had persisted in each case for at least several days in spite of intensive treatment and that it was effectively disposed of within a reasonable period after the initiation of oxygen therapy makes the correlation seem more than coincidental. The significance of the oxygen is not minimized by the observation that a large fraction of the distending gases was evacuated by peristalsis. That eventuality should indeed be anticipated in any case of distention of functional origin once the intestine has been relieved of the mechanical disadvantage of overdistention. It is precisely this function which we attribute to oxygen, for in each of the five cases reported the distention remained intractable to the ordinary therapeutic measures and yielded only after oxygen had been observed to decrease the degree of abdominal distention without a concomitant discharge of flatus (Cases I, III, and IV) or with only a negligible discharge (Cases II and V).

There should therefore be no need in the average case of ileus to rely on the administration of oxygen to complete the deflation except perhaps in instances of mechanical obstruction in which operation may be contraindicated, although this will admittedly be a rare circumstance.

Oxygen may prove quite useful in distended patients during a period when the surgeon is not certain whether he is dealing with a mechanical or functional ileus. In a recent experience of this type oxygen was given with the usual result of a decrease in abdominal girth, following which enterostomy was done for mechanical obstruction. At operation it was noted that most of the patient's residual distention was due to large amounts of intra-intestinal and intraperitoneal transudate.

In resorting to the use of 95 per cent oxygen for the treatment of distention we have not ignored the possible dangers involved. The available

evidence indicates that when it is given intermittently its toxic properties can be avoided. Our experimental data has demonstrated that intervals of respite in room air for one-half to one hour following three or four-hour periods in the helmet can be allowed without vitiating the effect of the oxygen already inhaled. Since the needs of the average patient will in any case require occasional interruptions and periods of rest outside the helmet the intermittent administration of oxygen proves to be more practical and at the same time safer than continuous administration. We have observed no untoward respiratory or cerebral effects in either man or animals from oxygen employed in this way for periods lasting as long as 24 hours, which is well within the limits necessary to accomplish the desired result.

The length of time necessary to effect a substantial improvement by oxygen cannot be predicted in any given instance. In the five cases cited the shortest period required was six hours. Since oxygen does not absorb gases from the stomach in any appreciable volume the use of the stomach tube to obviate the entrance of these gases into the intestine is a valuable procedure preliminary to the administration of oxygen and should shorten the time of sojourn in the helmet. Once in the helmet the patient can swallow only oxygen, a gas of no consequence in intestinal distention.^{2, 3} The selection of foods which are minimal gas producers² will, by preventing the accumulation of hydrogen in the gut, also decrease the period of time necessary for a successful issue.

Although our objective in devising this method is the treatment of obstinate distention such as may be encountered postoperatively, or in peritonitis, or perhaps in cases of suspected mechanical obstruction in which surgical relief is being withheld for one reason or another, its usefulness is by no means restricted to this purpose. Other possible indications are the following: (1) after operations on the gastro-intestinal tract when tension on suture lines must be avoided 95 per cent oxygen may serve as a prophylactic against the occurrence of distention because nitrogen, which is the chief constituent of the distending gases, is thereby excluded from the patient's environment. (2) The apparatus is conveniently applicable for the relief of anoxemia in cardiac and respiratory disorders. Indeed in instances in which anoxemia and distention coexist, a double purpose would be served. (3) Ninety-five per cent oxygen may find a possible usefulness in mediastinal emphysema. We have not as yet encountered a case for trial of the method but on theoretical grounds it may be worth a trial because the absorption of nitrogen from the soft tissues is accelerated by breathing pure oxygen. A recent investigation has established this observation beyond peradventure.¹⁰ (4) Finally, the method may be of value in patients suffering with severe or persistent headache following encephalography. This will be the subject of a forthcoming report.

CONCLUSIONS

- (1) Experimental evidence has been obtained which indicates that the

inhalation of 95 per cent oxygen may be effective for the relief of gaseous distention of the intestine.

(2) The inhalation of 95 per cent oxygen is therefore suggested as an agent for the treatment of intestinal distention when the usual methods available for this purpose are either contra-indicated or have proved unavailing.

(3) A safe, practical and economical method for the clinical administration of 95 per cent oxygen for this purpose is described. When properly used the dangers of oxygen poisoning can be avoided.

(4) Five patients with varying disorders, all victims of severe distention, were exposed to 95 per cent oxygen by means of this apparatus for periods varying from eight to 24 hours. The results do not conclusively demonstrate the clinical value of the method, but they are sufficiently gratifying to justify this preliminary report and to encourage further trial.

(5) Indications, aside from intestinal distention, for the use of the method are suggested.

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CYST OF WOLFFIAN ORIGIN WITH APLASIA OF KIDNEY AND URETER, HYDRONEPHROSIS AND UNDESCENDED TESTICLE

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CYSTS originating in the remains of the wolffian body are distinctly rare or relatively common depending upon the number of types one is willing to admit to this classification. Most authors, Ewing¹ for example, apparently accord the wolffian apparatus only a small rôle in the genesis of tumors, while others believe that it is the source of all retroperitoneal cystic tumors which do not demonstratively arise from one or other of the retroperitoneal organs. Some authors go even farther and include pseudomucinous cysts of the ovary (Monnier,¹³ Portes¹⁰), certain tumors of the testis (Ployé,¹⁸ Monserrat¹⁴), and cysts of the vagina (Lordy). Because of this confusion and because of the scarcity of references in the American literature, it is believed worthwhile to report all observed cases.

The two most recent comprehensive reviews in English are those of Maury¹² and of Hinman.⁷ These authors together collected 44 cases, including one each of their own, and the facts which they assembled relative to wolffian cysts are briefly as follows:

Retroperitoneal and mesenteric cystic tumors, arising apart from the retroperitoneal organs, although diverse in structure, nevertheless possess a common origin, namely, the wolffian body. The wide structural variations shown by individual cysts are explained by the variations in the structure of different portions of the wolffian body, any one of which may predominate in the cyst. All wolffian cysts have a fibrous wall which frequently contains smooth muscle. The lining consists of columnar or cuboidal, ciliated or non-ciliated epithelium. In the wall may be found, rarely, glomeruli and tubules. The cyst may be multilocular or unilocular, the contents serous, pseudomucinous, chocolate or gelatinous. Maury found chocolate cysts to be significantly frequent. Certain of the unilocular cysts are definitely derived from a persistent wolffian duct. The multilocular cysts are derived from the wolffian body, that is to say, secreting elements. In this latter variety adenomatous and papillomatous proliferation is prone to occur which may lead, as in ovarian cysts, to malignant degeneration. The growth capacity of all forms is great, many cysts reaching a volume of several liters.

Chief among the etiologic factors are age and sex. All cases have been reported in adults with two exceptions (Albarran; Hinman), the patients

being aged 10 and 27 months respectively. Females are affected almost exclusively.

The symptoms produced by wolffian cysts are in no manner characteristic, being due to the mechanical effects of an intra-abdominal mass. To these may be added the effects of malignant invasion of neighboring organs.

The treatment is entirely surgical, which is imposed because of the unlimited growth and the tendency to malignant change.

Since the appearance of Hinman's article (1934) 29 new cases have been published. Of these, 27 have been available to us. The study of these cases bears out in most essentials the conclusions already drawn concerning wolffian cysts as a group. The varieties previously reported reappear together with certain others possessing unusual or significant features. Moreover, with a larger number of cases available it is possible to individualize the wolffian group of cysts somewhat more completely than before.

There are two new examples of cysts containing glomeruli and tubules (Läwen,¹⁰ Sacerdote²³) which with one of our own brings the total number reported to six. For the first time there appears a wolffian cyst associated with anomalies of the urogenital system (Tscherne²⁷), the case of a girl 18 years old having an absent left kidney and ureter and a bicornate uterus.

The most perfect examples of persistent wolffian ducts are those of Läwen, Tscherne, Greig⁶ (two cases) and Troup.²⁶ The latter three were almost identical. They occurred in young children; the ducts led from a sinus at the vaginal orifice upward to the renal fossa. The ducts on removal had the general appearances of a varicose vein. The walls were composed of smooth muscle and fibrous tissue and were lined by transitional epithelium. Two of the patients had been treated for considerable periods for an intractable vaginal discharge. The third presented a vulval swelling.

There were four cysts reported which had developed from the caudal remnant of the wolffian duct (Gärtner's duct). Two of them involved the lateral wall of the uterus near the isthmus.^{3, 16} Lordly assigns two vaginal cysts to this category.

Cysts of the hydatid of Morgagni are common but are generally considered to be of little surgical interest. That the latter view is not justified is emphasized by Jeanneney,⁹ who reports three cases in which surgical intervention was necessary because of the large size of the cyst or because of complications.

Regarding location, the most unusual was that of Sacerdote, the cyst being attached to the round ligament at the external inguinal ring. The presence of glomeruli and tubules left no doubt as to the origin.

Two characteristics have been stressed which do not appear in the present series, namely, the bloody content of the cysts and the tendency to become malignant. In these cases, when stated, the fluid was serous or pseudo-mucinous. Only once was it hemorrhagic.² In only one instance did the author regard the tumor to be malignant, a tumor of the testis having teratoid features (Montserrat).

Apart from the cases in which glomeruli or ducts were in evidence, the basis for the diagnosis of wolffian cyst was variable.^{1, 5, 8, 15, 17, 20, 22, 24} In many, because the cyst was not connected with an organ, the diagnosis was made by exclusion. Much importance has been attached to the presence of ciliated epithelium.²⁵ Greig, in an exhaustive study, concludes that cilia are not necessarily characteristic of the wolffian body. The presence of smooth muscle in otherwise banal pseudomucinous cysts has been considered to be evidence of a wolffian origin, although these cysts admittedly may be of müllerian origin (Portes). In a cyst of the epididymis and in a cyst of the ovary Ployé and Monnier describe a structure which they regard as specific. They found all transitions from solid cords of epithelial cells to tubules to cysts.

The following personal case is reported because as a wolffian cyst it is rare and is doubly rare in that it combines most of the unusual features thus far observed.

D. W., white, male, two years 2 months old, was admitted to the Arkansas Children's Hospital, October 29, 1934.

Family History.—Father and mother living and well. One sister, a twin, is normal.

Past History.—The patient was in good health until two months ago. (Four months ago the parents noticed a mass in the left side of the abdomen, a fact learned subsequent to the operation.) The birth and early development were normal.

Present Illness.—The patient entered the hospital with the history of having swallowed a string of wooden beads two months before. Seventeen beads were recovered by an enema but since that time the patient had suffered from diarrhea, 5 to 12 movements daily, and vomiting. There was marked loss of weight. No pus, blood or mucus were observed in the stools. There were no symptoms referable to the urinary tract.

Physical Examination.—A poorly nourished white male child, two years old. Head, negative; ears, nose, eyes, negative; breath sounds, normal; heart, normal; abdomen shows an elevation in the left lower quadrant. Palpation in this region demonstrates a dumb-bell shaped mass which extends upward and laterally somewhat above the level of the umbilicus. The lower half of this mass is the larger and it extends toward the midline; it is firm but elastic, moves with respiration, and its surface is irregular. The left testis is undescended.

Working Diagnosis.—Mass in left lower quadrant with possible partial obstruction of the left colon by remaining beads. Roentgenologic examination of the abdomen was negative. *Blood Count*—Hemoglobin, 70 per cent.; erythrocytes, 5,200,000; while cell count, 16,000; Shilling, 0-1-0-11-12-61-16-7.

Urine Examination.—October 29; clear, trace of albumen, no sugar, occasional squamous epithelial cell, 10 to 15 pus cells per high power field, occasional hyaline cast. November 1, urine clear, straw colored, acid; albumen 2 plus, no sugar, many pus cells, occasional erythrocyte, many bacteria, a few granular casts.

Operation, November 3, 1934: Left rectus incision, appendectomy, removal of undescended testicle. In the left side of the abdomen was a large mass of thin walled cysts almost completely filling the left lower quadrant and extending a little above the level of the umbilicus. The pedicle was attached to the posterior abdominal wall slightly above the level of the umbilicus and to the undescended testicle and its vessels. The colon was pushed toward the midline. The cysts were removed intact. The right kidney appeared normal; the left could not be palpated.

Postoperative Course.—The first four days the temperature ranged from normal to

101.2°. November 9, the dressings were wet with a material resembling urine. Microscopically, the fluid contained much pus. The abdomen at this time became distended. November 10, child began to have convulsions and died in about six hours.

Autopsy: Diagnosis.—Hypostatic hyperemia of the lungs; cloudy swelling of the heart and liver; acute splenic tumor; suppurating laparotomy wound; purulent peritonitis; complete absence of the left kidney and ureter; right hydronephrosis and hydro-ureter; stricture of the ureter at its junction with the bladder; surgical removal of a left abdominal testis. In detail the situation in the genito-urinary tract was as follows: "The left renal fossa is denuded of peritoneum . . . the spermatic vessels have been sectioned just below the iliac crest. The left vas deferens cannot be discovered. There is no vestige of a left ureter or kidney. The pelvis of the right kidney is markedly dilated and elongated, the vertical measurement being 3.5 cm. The dilated calices can be readily palpated through the thinned parenchyma of the kidney. The right ureter is



FIG. 1.—Urinary tract and cyst photographed in approximately their original relations.

dilated to a diameter of 1 cm. in its upper three-fourths. Below it tapers to enter the bladder. At the point of entrance is a definite constriction which opposes the passage of fluid in either direction. The urinary tract is removed intact." Subsequent gross and microscopic examination of the specimen failed to reveal a spermatic cord or seminal vesicle on the left side.

Pathologic Report.—"The specimen consists of a cluster of thin walled, serous cysts, which form a lobulated oval mass measuring 9 by 7 by 5 cm. (Fig. 1). and a testis. The walls of the cysts are pearly white and they cut with the consistency of dense fibrous tissue. The inner surfaces are smooth and glistening. The cysts number about 15 and they vary from 0.2 to 4.5 cm. in diameter. All obviously arise from a central solid mass of vascular fibrous tissue which measures 3.0 cm. in its greatest diameter.

Microscopic Examination.—The cyst walls are composed of a lining membrane of flat cells, a smooth muscle and a fibrous tunic (Fig. 2). In the central mass and in the thicker portions of the walls of the cysts are numerous well formed glomeruli and tubules (Fig. 3). The tubules are of two types: (1) In close relation to the glomer-

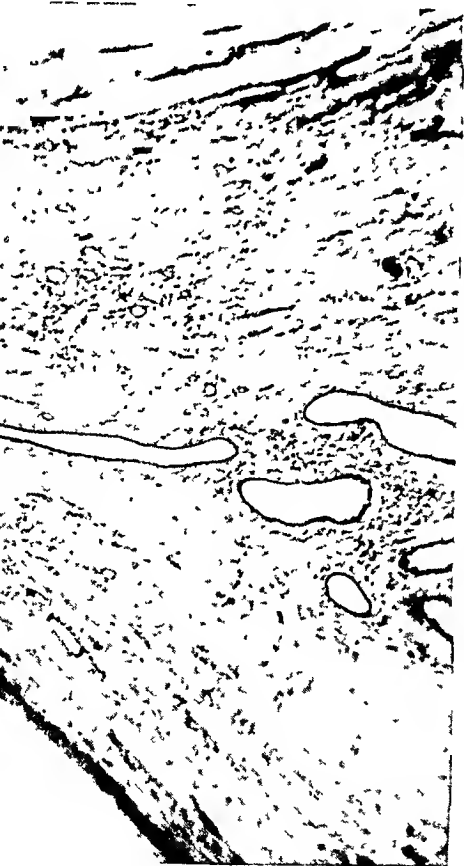


FIG 2 —Low power (32 obj 10 X ocular) photomicrograph of the common wall of two small cysts



FIG 4 —Widely distributed type of tubule from which the cysts appeared to develop.



FIG 3 —Tubules and glomeruli found in the central solid portion of the cyst



FIG 5 —Widely distributed type of tubule from which the cysts appeared to develop.

uli are tubules with narrow lumina; the constituent cells are cuboidal, the nuclei are small and vesicular and the cytoplasm is abundant, pale and finely granular. (2) Widely distributed in the cyst walls are tubules formed of cuboidal cells having scanty clear cytoplasm and large, vesicular, deeply staining nuclei. The cells tend to pile up in places and project into the lumina. Some of the cells, particularly at the apices of the projections, possess protoplasmic processes (Figs. 4 and 5). These tubules are found in all stages of cystic dilatation. In none of the above tubules are brush borders observed.

The testis shows the normal infantile structure. The epididymis is not included in the section and the remains of the original block cannot be found.

Diagnosis.—Multilocular serous cyst, probably of wolffian origin. Infantile testis.

Comment.—The cyst could have had one of two origins, the metanephros or the mesonephros. Examination of the embryologic material at our disposal was of no aid in deciding the matter. Histologically, the glomeruli and the tubules immediately associated with them gave every appearance of being derived from the metanephros. It was noted, however, that the larger, dilated tubules in the cyst walls were quite foreign to anything seen in the normal kidney and the presence of cilia-like structures was quite in keeping with a mesonephric origin.

Multiple anomalies of the urogenital tract in association with a wolffian cyst are of interest chiefly because they have been reported only once before. There is no evidence that anomalies play a part in the etiology of cysts of this nature.

DISCUSSION AND CONCLUSIONS

Among the varieties of abdominal tumor which must always be considered in a differential diagnosis is a small group of cysts taking their origin from the wolffian body or duct. These cysts occur almost exclusively in adult females. They may be intramesenteric or retroperitoneal and may be located from the renal fossa to the pelvic floor but are usually found on the left side of the abdomen. They grow slowly and are benign but reach large size. Important attachments to adjacent organs may be acquired which complicate an otherwise simple extirpation. The structure is variable but always includes some component of the wolffian apparatus. A common and characteristic form is a persistent duct which, as Greig has pointed out, is often mistaken for a supernumerary ureter. Equally characteristic but extremely rare are cysts containing glomeruli and tubules. Most commonly reported are unilocular or multilocular cysts which form an apparently heterogeneous group structurally. The diagnosis is usually made on the basis of exclusion or on the basis of certain histologic characteristics which are variously evaluated by different authors. It is only by a careful study of this last group that the actual limits of the category of wolffian cysts will be established.

For his aid in preparing the bibliography for this article we are deeply indebted to Dr. Alphonse Pirnèque who graciously placed at our disposal his talents as a linguist.

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RENAL LIPOMATOSIS

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SINCE Kutzmann's scholarly essay on lipomatosis of the kidney, a renewed interest has been taken in this subject. In spite of a rather extensive literature, the pathologic process is little understood, and, like many subjects in medicine, is enmeshed in a fog of theories. However, as case reports accumulate, certain facts are developed which gradually throw light upon the etiology and the manner in which the pathologic changes occur. Many who have studied renal lipomatosis are essentially agreed on several points. These will be taken up separately.

Adipose Tissue in the Renal Parenchyma.—There are two well defined groups exhibiting abnormal adipose invasion of the glandular portions of the kidney. The first is the lipoma. This is usually a well circumscribed encapsuled mass of fat analogous to other growths. It is usually attached to some portion of the renal capsule. As a rule they are not large, but the fat tumor dips well into the parenchyma. In the kidney itself we find no pathology of the glomeruli or tubules, except a very limited area around the adipose mass producing compression. It is possible that Young's recently reported case comes under this group. Examinations of his case failed to show any indications of infection, pyuria or nephrolithiasis. The invasion was from the hilus and involved only a small part of the parenchyma.

In contradistinction, renal lipomatosis gives a picture of renal degeneration, often accompanied by pathologic evidence of infection and then a displacement of the normal glandular structure by fat cells. Tissue specimens from these kidneys often show sharply defined areas where this transformation is taking place. There is enough evidence produced from all the cases reported, except the one by Young,¹ to show that unilateral upper urinary tract infection is a decided factor. All of the microscopic sections show leukocytic invasion and destruction of tubules and glomeruli. In addition, there is noticed occlusion of the renal arteries and veins in the area involved. Some process is at hand which causes this atrophy, either toxic or impaired blood supply. Furthermore, the very high incidence of calculus in these kidneys has been widely observed and reported. Kutzmann's study of all reported cases had an incidence of 79 per cent of calculus formation.

There is some confusion in the terminology of lipomatosis of the kidney as lipomatous nephritis, replacement lipomatosis (Askanazy), degeneration lipoma (Ulrich), fatty degeneration, lipomatous paranephritis, substitute renes adiposa (Hillman) and other terms. However, authorities are all in accord on the following differentiation. Lipoma of the kidney is a circumscribed fat tumor occurring in normal kidney tissue. In lipomatosis

there are marked atrophic degenerative changes and many are inflammatory with an invasion or substitution of fat cells. Gradually the fat replaces the normal renal infections, thus tuberculous, *B. coli*, and staphylococcus processes can produce a fibrosis of the kidney and bring about a non-functioning condition known as autonephrectomy. These may contain extensive calcium deposits.

Incidence.—The condition is relatively rare. In 40,000 autopsies over a period of 20 years at the Berlin Institution, only one case of fatty tumor of the capsule was encountered. Since Kutzmann's⁴ study, in 1931, of 33 cases, 13 new ones have appeared in literature, one each by Kretschmer,³ Culver⁵ and Young, with a joint case report by White and Cambridge.² Many of the cases reported were found on exploratory operation or autopsy.

Clinical Symptoms.—There are few outstanding symptoms. Frequently pain is absent. When present it is usually a mild ache and does not radiate. When infection is marked, the usual symptoms of the lower urinary tract are complained of, as frequent micturition and burning.

Objective symptoms are infection of the urine with pyuria. Blood chemistry estimation and renal function tests are often normal, due to the normal kidney on the other side. Roentgenologic studies give a calculus shadow or filling defects similar to renal tumor.

It is a disease chiefly of the fourth or fifth decade of life. The youngest individual reported was ten years of age. It falls within the degenerative period of life. The kidney becomes functionless, hence there is seldom hematuria or colic. It is practically always unilateral. The process is always slow and progressive.

CASE REPORT

Male, aged 77, single, born in Germany, retired optician, was referred by Dr. Harry Friedman July 16, 1930. He was admitted to the Providence Hospital complaining of dysuria. Little of interest was obtained from the family history. *Previous History.*—Childhood infections and bilateral inguinal hernia of 18 years' standing.

The present illness apparently started six years ago. The act of micturition was interfered with by a gradually increasing obstruction producing increased frequency of urination, day and night, a stream of small volume and weakened force, but never a complete obstruction, gradually pain in the pelvis, dysuria, pyuria, mild hematuria and indefinite pain in the small of the back. In time cardiac symptoms developed, *i.e.*, dyspnea after normal body movements, palpitation and a sense of alarm, due to pain over the heart. He was treated for a myocarditis of toxic origin. The dysuria became so distressing that he was hospitalized for a study of his lower urinary tract.

The physical examination showed a small statured, elderly male of good nutrition. The teeth are artificial. The eyes are marked with an arcus senilis. The heart is normal in size but the sounds are weak and distant, somewhat irregular, but no bruit. The abdomen is distinctly globular below the umbilicus, so common in visceroptosis. The right inguinal ring is occupied by a large hernia and the left a smaller one. The kidneys are not

palpable and give no evidence of tenderness. The external genitals are negative. Rectal palpation showed a prostate moderately enlarged, 4 by 5 cm., spherical, with a slightly rough surface. The urine is turbid, blood tinged, specific gravity 1.008, albumin 5.5 per cent by volume, sugar absent, microscopic examination showed many blood cells, numerous pus cells and colon-like bacilli. Culture of the prostatic secretion was rich with the same organism.

Blood examination showed urea nitrogen 15.4 mg. per 100 cc. of blood, creatinin 1.2 mg. and sugar 100.0 mg. Hemoglobin, 55 per cent; erythrocytes, 3,990,000; leukocytes, 10,900; and polymorphonuclears, 70 per cent. Intravenous phthalein returned 25 per cent in the first, and 10 per cent in the second hour.

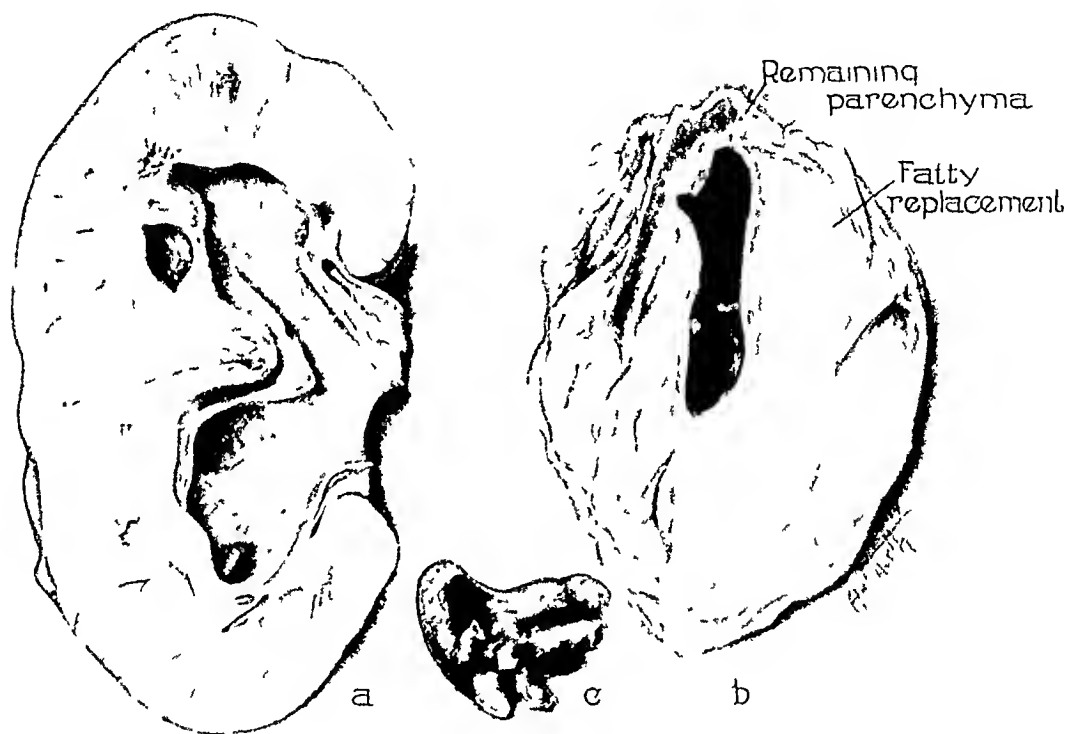


FIG 1.—Drawing of both kidneys (a) Right kidney (b) Left kidney. (c) Calculus found in left kidney

An indwelling catheter disturbed the patient so much mentally as well as physically that a suprapubic cystostomy was performed July 17, 1930, using novocain infiltration anesthesia. The bladder wall was thickened and its mucosa was greatly inflamed, bathed in hemorrhagic urine. The internal urethral orifice was contracted. A Pezzer catheter was inserted and the bladder drained until August 8. On this date the bladder wound was reopened and the internal urethral orifice was forcibly dilated with the finger. Several pieces of prostatic tissue were removed with scissors. An abscess was located beneath the trigone. The tissue removed was diagnosed as suppurative and inflammatory. Convalescence was slow. In spite of the persisting urinary infection the suprapubic wound healed in three weeks. The patient returned home. Dysuria was not improved so the patient returned to the hospital November 28. A cystoscopic examination was made under spinal anesthesia. The bladder capacity was 90 cc. The urine was purulent. The internal urethral orifice showed edematous tags. The ureteral orifices

were not located due to a diffuse cystitis. The patient very gradually became weaker and died January 2.

Autopsy.—Subject is an emaciated adult white male, appearing about 70 years of age. Suprapubic wound, partially healed, draining purulent fluid.

Body cavities opened in usual manner. Small amount of fluid in both pleural cavities. Right pleura extensively bound by fibrous adhesions, right lung tough and fibrotic. Slight edema of both lungs. Heart is of normal size, but is pale and mottled in color. Depressed area of fibrosis left ventricle. Coronaries narrow with small plaques. Valves competent. Few soft atheromata in aorta.

Abdomen.—Liver is of average size but is pitted by numerous stellate areas as if fibrotic, giving it a nodular appearance and feel. Gallbladder and ducts normal. Liver substance of yellow color. The fatty degeneration stage of chronic passive congestion. Stomach and intestines normal. Spleen is enlarged one and one-half times, with a thick nodular fibrous capsule. Bladder is thick, contracted, and congested. The prostatic area is smooth, urethral orifice patent. Portion of the prostate removed is soft and uniform. Left kidney is intimately bound to perirenal fat and fibrous tissue. On opening only a thin rim of parenchyma is found at one pole, balance has been replaced by fat and fibrous tissue, with a central sac filled with thick creamy pus, also a staghorn calculus (Fig. 1). Right kidney is large, soft and boggy. Capsule stripped with difficulty, revealing an outer surface which is riddled by discrete and confluent yellowish necrotic areas. On longitudinal section yellowish pus was evacuated from the pelvis; parenchyma is shot with necrotic yellowish areas.

Microscopic.—Prostate shows moderate hyperplasia, dense inflammatory infiltration and areas of necrosis. Right kidney.—Discrete and confluent areas of focal inflammatory infiltration, leukocytic and lymphocytic. Considerable necrosis. No evidence of tuberculosis. Degeneration of kidney parenchyma.

Anatomic Diagnosis.—Bilateral pyonephrosis, left renal calculus; chronic cystitis, chronic prostatitis; chronic passive congestion of the liver, numerous healed infarcts; chronic fibrous perisplenitis; chronic myocarditis; edema of lungs; fibrous pleural adhesions, fibrosis right lung.

Tissue Report of the Kidney.—The left kidney measures 10 by 6 by 5 cm. One pole and sides consist of a crescent shaped portion of yellowish-brown tissue, resembling kidney parenchyma. This is sharply marked off from and surrounded by fatty tissue which has replaced all other structures in the kidney. The pelvis and calyces contain a large staghorn calculus measuring 3.5 by 3.5 by 1.5 cm. Portions of the fatty tissue show lobulation.

Microscopic examination of the kidney shows the tissue surrounding the small amount of kidney parenchyma to consist of fatty tissue containing numerous collections of round cells (Fig. 2). There is a very sharp demarcation, separated by fibrous tissue, between the fatty tissue and parenchyma (Fig. 3).

The parenchyma shows an extensive destruction and fibrosis of the glomeruli and tubules with areas of hyaline degeneration, together with a diffuse infiltration and collections of round cells (Fig. 4). The smaller arteries show narrowed lumen, marked thickening of the wall by fibrosis and hyaline changes.

Pathologic Diagnosis.—Replacement lipomatosis of the left kidney; pyonephrosis; renal calculus.

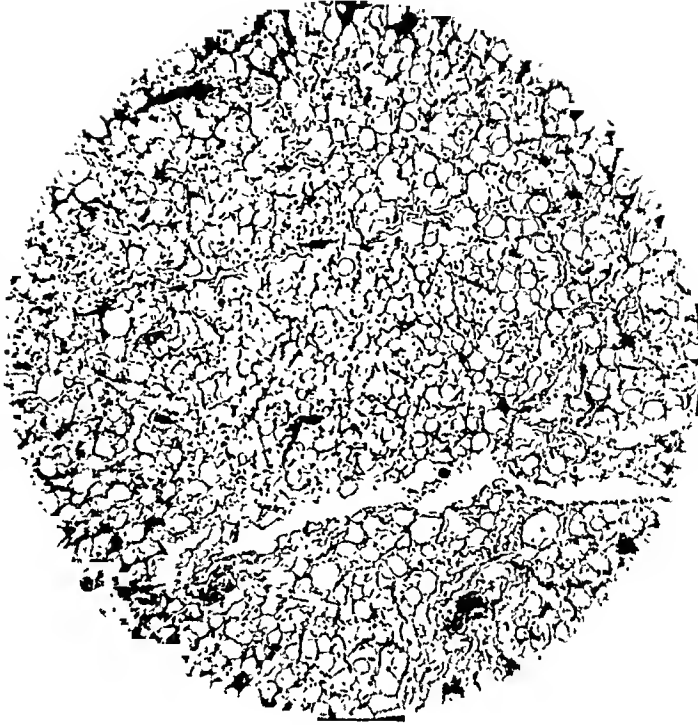


Fig. 2.—Photomicrograph (low power) showing the structure of adipose tissue which has replaced the kidney parenchyma. Note the diffuse round cell infiltration.

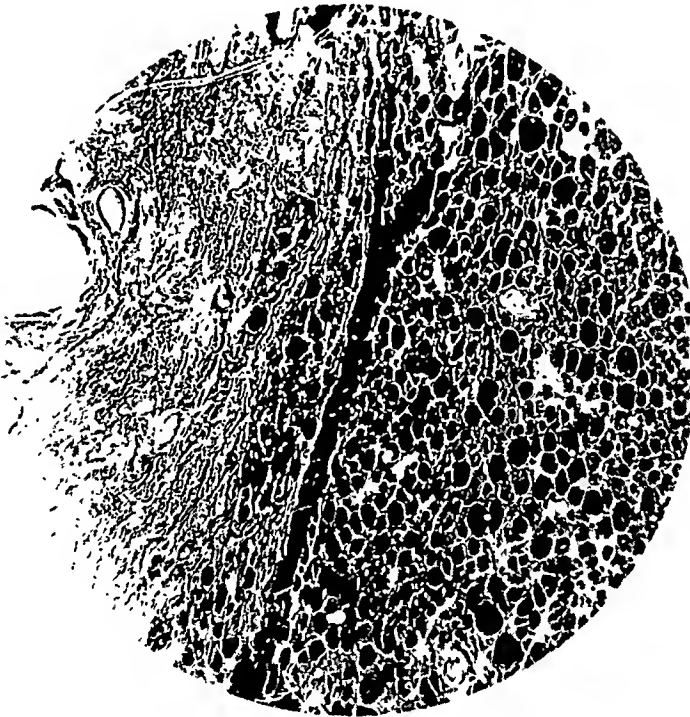


Fig. 3.—Photomicrograph (low power) showing the sharp demarcation between the adipose tissue and the fibrous renal parenchyma.

The interesting lessons taught by this particular case are, first, that chronic infection of the lower urinary tract in the aged usually involves the kidneys; second, that the blood chemistry estimation is often misleading as to the true extent of renal damage by infection, and third, when lower urinary tract pathology exists a complete roentgenologic study should be made of the entire urinary system whenever possible.

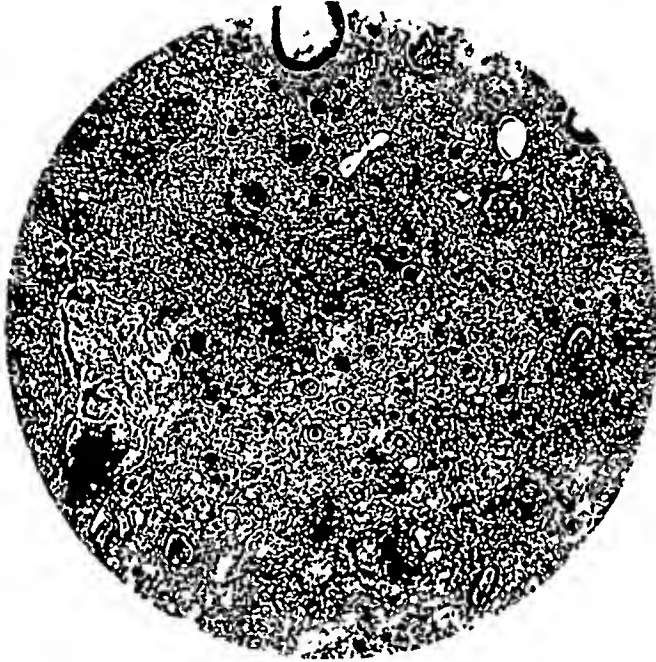


FIG. 4.—Photomicrograph (low power) showing the remaining renal parenchyma, with destroyed fibrous areas, marked inflammatory cellular infiltration. Many miliary abscesses scattered throughout.

SUMMARY

(1) Renal lipomatosis is the result of a degenerative atrophic process, due to bacterial toxins. Renal lipoma shows no degenerative changes in the parenchyma, thus differentiating it from replacement lipomatosis.

(2) The normal kidney cells become altered. Globules of fat replace the contents of the cells.

(3) The action of bacterial toxins and lack of oxygen bring about a cell degeneration.

(4) The degeneration is primary and the fat replacement secondary.

(5) Nephrolithiasis almost invariably is a result of these changes.

(6) Symptoms and diagnosis are often obscure. Most cases are found on exploration or autopsy.

(7) Lipomatosis is a disease of the degenerative period of life.

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TRUE HERMAPHRODITISM

REPORT OF A CASE WITH NECROPSY

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THE medical literature contains many references to hermaphroditism. Despite the widespread interest in this condition, the confusing terminology and the paucity of pertinent data in many reported cases make this one of the least understood subjects in medicine.

True physiologic hermaphroditism would necessitate functioning glands and accessory organs of both sexes in one person. The nearest approach to this condition was a case with bilateral ovaries and testes reported by Masson,¹ who found menstrual blood in the uterus and spermatozoa in the ducts. Kwartin and Hyams² were unable to find a higher stage of spermatogenesis than spermatocytes in the photomicrographs from Masson's patient and it is generally conceded that true physiologic hermaphroditism does not occur in vertebrates.

The term true or glandular hermaphroditism is applied correctly only to individuals with both male and female gonads. The glands may be discrete or fused to form an ovotestis. Broman³ divided true anatomic hermaphroditism into three groups:

(I) Hermaphroditismus bilateralis. Testis and ovary present on both sides (either separate or united ovotestis).

(II) Hermaphroditismus unilateralis. On one side testis and ovary present. On the other side either one or the other.

(III) Hermaphroditismus alternans. Testis on one side and ovary on the opposite side. (The alternans also called lateralis.)

Kwartin and Hyams² reported a case in 1927 and found 11 other proven cases in a critical review of the literature. They conclude: there is always a mixture of external male and female sexual characteristics; most undoubted cases possess either unilateral or bilateral ovotestis; the ovarian part of the ovotestis usually lies cephalad, the testicular dorso-caudad; the testicular component is usually larger in size than the ovarian; the ovarian portion is almost always highly differentiated, with activity on the part of the ovarian stroma; the testicular portion is small, atrophic or rudimentary and histologically exhibits more or less completely the features of a cryptorchid testis without mature spermatozoa although the interstitial cells may be well developed, especially after puberty.

Kwartin and Hyam's² collected series of true hermaphroditism included only three cases occurring in America (Masson,¹ Young⁴ and their own case). Essenberg and Feinberg⁵ have since reported a microscopically proven

case. McFarland⁶ and Urechia and Teposu⁷ have recently reported undoubted cases of true hermaphroditism although they were able to obtain microscopic sections from only one type of gonad.

The term pseudo or tubular hermaphroditism has been loosely applied to many conditions. Strictly speaking, this term includes any persistence of the müllerian or wolffian ducts beyond the vestigial remains usually found in normal persons. These embryonic remains may vary in differentiation from a simple tubular structure accidentally encountered at operation or necropsy to the completely differentiated tubular accessory structures of the opposite sex. Heyl's⁸ recent article reporting a case of probably minimal pseudohermaphroditism found during the repair of an inguinal hernia suggests that this condition may frequently pass unrecognized. Highly differentiated pseudohermaphrodites can be distinguished from true hermaphrodites only by careful microscopic examination of the gonads, and inability or failure to do this will leave the status of a case undetermined.

The interesting question of the relation of hermaphroditism to sex differentiation is not discussed in this paper. The significance of this relationship has been presented admirably by Jordan⁹ and Jordan and Kindred.¹⁰

CASE REPORT

H. M., an elderly Negro, who appeared older than the stated age of 60, was admitted to Saint Philip Hospital October 31, 1933, complaining of abdominal pain and vomiting of four days' duration.

The family history was not significant. Little information could be obtained regarding the health or cause of death of the patient's immediate relatives. No congenital abnormalities were recalled.

The past history was fragmentary and was obtained from a relative following the death of the patient. A large right inguinal hernia had been present since birth and had handicapped the patient to such a degree that heavy manual labor had been impossible. The presence of the hernia and a marked hypospadias was known to the patient's associates during childhood and had given rise to the supposition that the subject was a hermaphrodite. This early impression apparently was refuted when upon reaching maturity the patient married. The union proved mutually satisfactory and was terminated only by the death of the wife from tuberculosis. This was followed by a second marriage which ended in a divorce when the wife proved unfaithful during the patient's absence from the city. A third marriage in middle life was followed by a separation because of conflicting personalities. No pregnancies resulted from these unions. The third wife stated that the patient was not impotent. A history of periodic hematuria could not be obtained. In recent years the patient's activities were limited by the inguinal hernia. About six months before admission to the hospital weakness and loss of weight were noted, but the patient attributed this to advancing years and the ever increasing hernia, which was then irreducible.

The present illness was of short duration. On October 27, the hernia became larger, the patient developed cramping abdominal pain and vomited several times. These symptoms persisted and the patient was admitted to the hospital four days after the onset of the obstruction.

Physical examination revealed an acutely ill, elderly individual, apparently masculine, of medium stature. Although the patient had a moderate beard, the breasts were rather large, the hips were wide and the thighs were definitely feminine in contour. The head and neck were negative aside from advanced dental caries. The

heart was enlarged, the apical impulse was situated in the sixth interspace 4 cm. lateral to the midclavicular line. The blood pressure was 140/85. The abdomen was distended and generally tender. A fulness in the region of the right inguinal canal was continuous with an irreducible right inguinal hernia which measured 69 cm. in circumference (Fig. 1). The scrotum was tense and the skin was ulcerated where the hernial protrusion rested upon the inner surface of the thighs. The penis was hidden in a sulcus in the upper medial portion of the hernia. Temperature, 99°; pulse, 120;



FIG. 1.—Preoperative photograph showing size of hernia. Note distribution of pubic hair and contour of pelvis and thighs. The penis is almost completely hidden by the hernial protrusion.

and respirations, 24 The patient was catheterized with difficulty due to the hypospadias and invagination of the penis in the scrotum. Urinalysis negative except for a slight trace of albumin. Routine blood studies were not remarkable. The patient obviously had an intestinal obstruction resulting probably from a strangulated right inguinal hernia. A continuous intravenous injection of 5 per cent dextrose in normal saline solution was begun. A gastric lavage released a large amount of gas but no gastric contents.

Operation.—Twelve milligrams of pantocain were injected intraspinaly. The hernial sac contained a large amount of omentum, cecum, ascending colon, and the greater

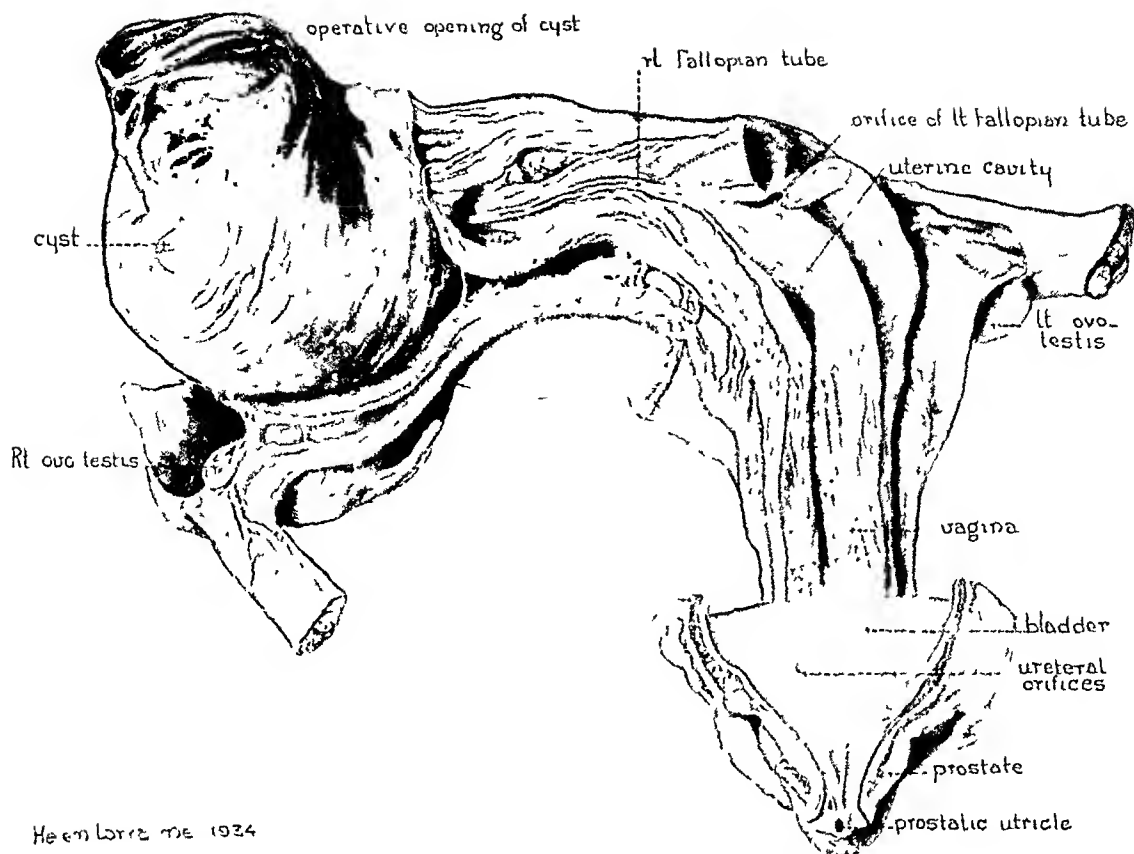


FIG. 2.—Drawing showing anterior view of specimen.

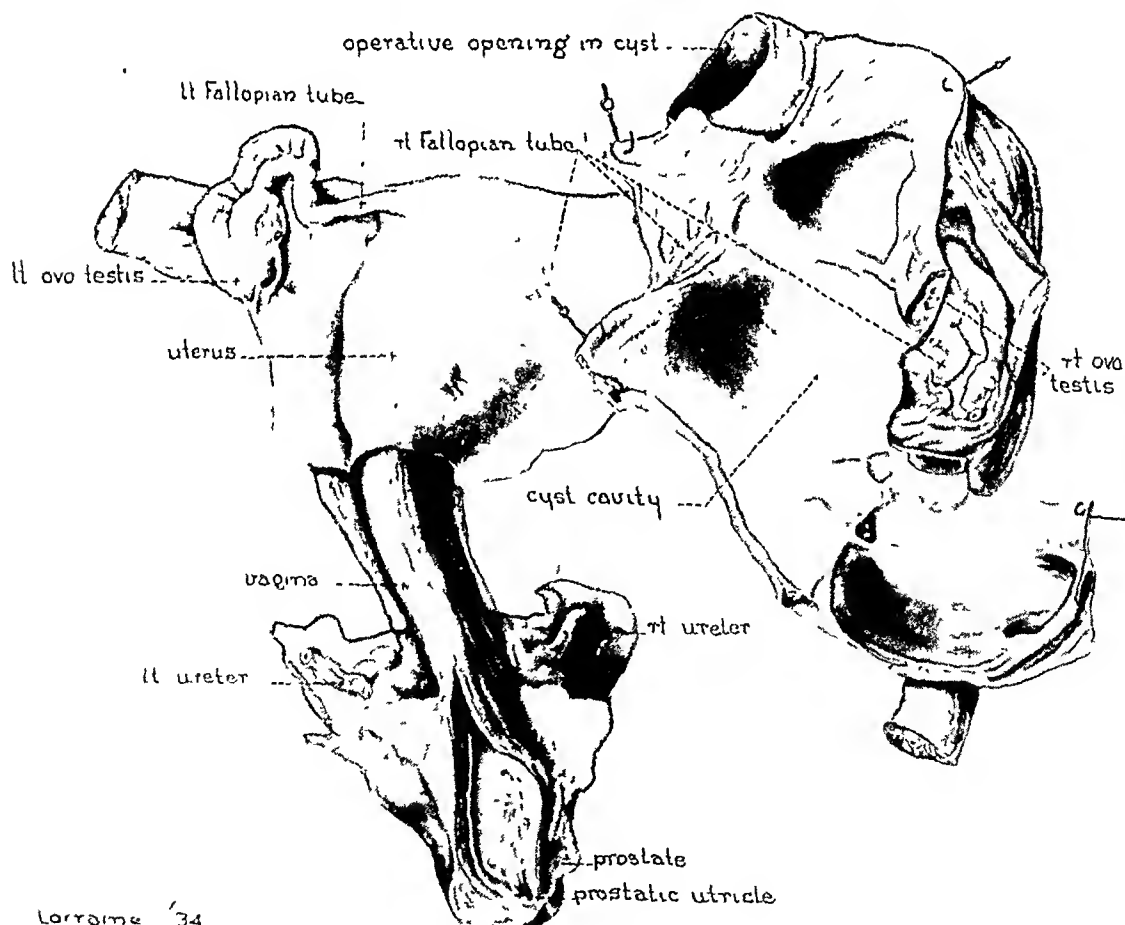


FIG. 3.—Drawing showing posterior view of specimen.

portion of the ileum. The serosa of the omentum and bowel was studded with small gray elevated nodules which resembled peritoneal implants from an intra-abdominal carcinoma. The primary obstruction was located in the terminal ileum where adherent metastatic nodules bound the adjacent loops of intestine together with angulation and a complete obstruction at this point. The resulting dilatation of the ileum proximal to the angulation had in turn caused a secondary obstruction at the neck of the sac with marked distention of the jejunum. A biopsy from the omentum showed metastatic adenocarcinoma probably arising from the pancreas. In dissecting free the adherent loops of small intestine a cyst about 10 cm. in diameter was found adherent to the posterior wall of the hernial sac. This contained straw colored fluid and was thought to be a hydrocele. Adherent to and projecting from the outer wall of the cyst was a small solid structure which resembled a cryptorchid testis. These structures were continuous with a large unidentified organ within the abdominal cavity. The condition of the patient was unsatisfactory and a more detailed examination could not be made. The obstruction was released, the contents of the sac were returned with difficulty to the abdominal cavity and the hernia was repaired. In view of the marked distention a catheter jejunostomy was made through a left muscle splitting incision.

The patient improved for a short time following operation but the abdomen again became distended, the non-protein nitrogen of the blood increased, the extensive ulceration on the under surface of the scrotum bled freely and death occurred three days after operation.

Necropsy.—(Abstracted to include only relevant data.) Gross description: Case A 1139. Body examined November 3, 1933, five hours after death. Well nourished Negro. Apparent age, 65 years; length, 160 cm.; estimated weight, 65 Kg. The beard and mustache are developed to a moderate degree. The mammary glands are considerably larger than usually is observed in males, and the nipples are quite prominent. The width and contour of the pelvis and the conformation of the lower extremities are very suggestive of the female type. The pubic region has been shaved for surgical procedures. The scrotum, which is excoriated superficially, measures approximately 20 cm. in diameter, and almost obscures the short penis which presents a penoscrotal hypospadias. The testes are not contained in the scrotum.

Median abdominal section reveals the following anomalous formations: Projecting upward between the urinary bladder and the rectum is an unusual bulky muscular structure which resembles a malformed uterus (Figs. 2 and 3). The upper portion of this organ is loosely attached to the lateral walls of the pelvis by relaxed ligamentous structures. The lower portion is adherent to the prostatic urethra near the base of the bladder. It contains a central canal which communicates with the prostatic urethra through the utricle orifice, the latter being located in the usual position. A probe passes freely through this orifice and enters the canal which measures 8 cm. in length and about 1 cm. in diameter. This portion suggests a vagina, and is lined with a glistening mucosa which presents longitudinal rugae. The cervix is not well defined. The upper end of this vaginal-like structure merges into a thick walled portion resembling the fundus uteri. The uterine cavity is 10 cm. in depth and the wall varies from 1.5 to 2 cm. in thickness. It is grossly identical with myometrium. The fundus deviates to the right and extends into the right cornu, where it diminishes markedly in caliber and emerges on the posterior surface of the right ligamentous structure as the fallopian tube.

This tube is 12 cm. in length and tortuous near the end of its course; it terminates abruptly without a fimbriated extremity near a firm ovoid-shaped structure. This mass measures 2.5 by 1 by 1 cm. in size and is grayish-red in color. Section reveals a firm reddish and mottled gray surface containing several cystic spaces. Medial and slightly posteriorly is situated a smooth walled evacuated cyst which measures approximately 10 cm. in diameter.

The left fallopian tube arises from the somewhat ill defined left cornu of the

uterus. This tube measures 4.5 cm. in length and terminates in an ovoid shaped firm mass which is 2.75 by 1.5 by 1.25 cm. in size. It is pale, reddish-gray in color. Section reveals a small cyst associated with calcified material. The remainder of the surface is rather homogeneous and dark red. Superimposed upon this ovoid mass and in-



FIG. 4.—Section showing atrophic endometrium and a portion of the myometrium.

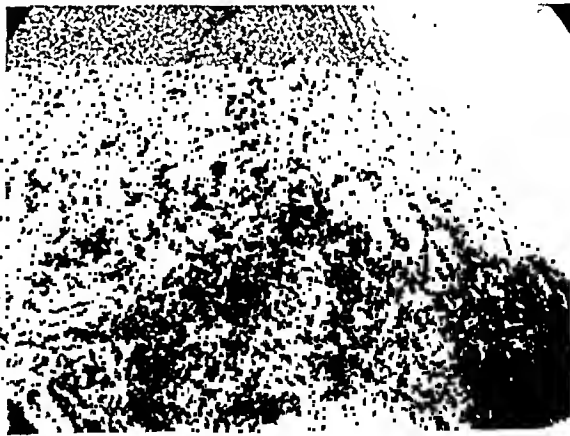


FIG. 5.—Section from left ovotestis showing both testicular and ovarian elements.



FIG. 6.—Cross section of left fallopian tube near uterine end.

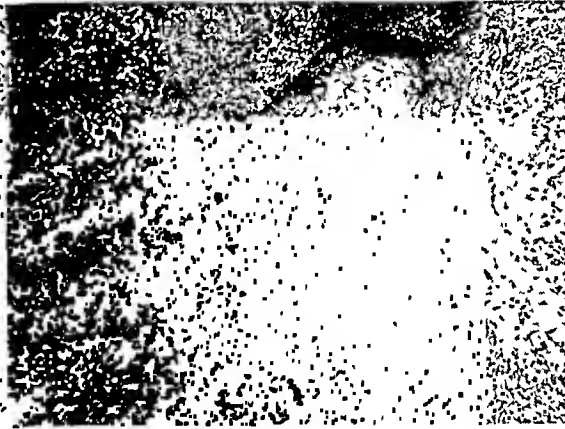


FIG. 7.—Section from right ovotestis, showing ovarian stroma and a corpus albicans.



FIG. 8.—Another view of right ovotestis, showing mainly testicular elements. From near opposite end of organ seen in Fig. 7.



FIG. 9.—Cross section of right fallopian tube near the distal extremity.

separably associated with it is a grayish-white convoluted structure of delicate configuration. Fimbriated extremity cannot be demonstrated.

A small shallow prostate surrounds the urethra in the usual location. Seminal vesicles and vasa deferentia cannot be demonstrated grossly.

Small metastatic carcinomatous nodules are sparsely distributed in various areas of these pelvic structures. The carcinoma is primary in the pancreas.

Microscopic Examination.—The fusiform muscular structure reveals myometrium and atrophic endometrium (Fig. 4).

Section from the ovoid shaped mass on the left side shows ovarian stroma embracing corpora albicantia (Fig. 5). Testicular tissue is noted in another portion of the section which is continuous with the ovarian elements. The ovarian elements assume a cortical location while the testicular tissue is centrally placed or medullary. The convoluted structure noted in the gross associated with this ovotestis shows the configuration of an epididymis.

Section of the left tubal structure from near the uterine end is identified as fallopian tube from that location (Fig. 6).



FIG. 10.—Section from prostate gland.

The ovoid shaped mass on the right side presents a somewhat different position of predominating elements. Section selected from nearer one end presents mainly ovarian stroma and corpora albicantia (Fig. 7) associated with an inconspicuous number of cryptorchid testicular elements embracing atrophic seminiferous tubules which are hyalinizing and disappearing. In sections removed from nearer the opposite end the elements are predominantly testicular in character (Fig. 8), the interstitial cells being very abundant. This observation of distribution of various elements was made by Doctor Jordan, who also identified the region of transition from epididymis to ductus deferens in another section which was removed from close proximity to this right ovotestis.

Section from near the termination of the thin walled narrow channel, or continuation of the uterine canal towards the right, presents, the histologic picture of fallopian tube (Fig. 9).

The prostate (Fig. 10) presents a typical picture of the glandular and stroma elements of that organ. The appearance is compatible with prostatic tissue of a much younger individual than the subject of this report.

Breast section shows an occasional lactiferous duct and a few atrophic acini.

SUMMARY

(1) A case of true anatomic bilateral hermaphroditism in an elderly Negro is reported. The following structures were identified: bilateral ootestes; fallopian tubes; a uterus with a distal prolongation which grossly resembled a vagina; epididymi; and a prostate. A ductus deferens was found on one side. The penis presented a penoscrotal hypospadias.

(2) This anomaly was associated with a large congenital inguinal hernia containing a cyst which arose near the right ovotestis.

(3) The patient considered himself male. He married three times and apparently led a normal sex life.

(4) The incidence and various types of true hermaphroditism are given but no attempt has been made to discuss the theories as to the causation of this condition.

We are indebted to Dr. H. E. Jordan, Professor of Embryology and Histology at the University of Virginia, School of Medicine, and to Dr. Hjalmar Osterud, Professor of Anatomy, at the Medical College of Virginia, for assistance in this study.

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PRIMARY CARCINOMA OF THE EXTREMITIES

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THIS report is part of a general study of the clinical aspects of soft tissue tumors of the extremities. The intention has been to emphasize the clinical syndrome presented by each of these tumors in order to facilitate early diagnosis and better prognosis. Even though their pathology has been adequately described, a high percentage of false preoperative diagnoses has heretofore marked every series of hospital records examined. This has been due entirely to a failure to appreciate their clinical differential characteristics. Those of carcinoma are herewith presented.

Primary carcinoma occurs in the extremities infrequently but by no means rarely. In 1926, De Asis collected 17 cases¹; in Stout's series of 51 skin epitheliomata, 17 involved the extremities.² The present study is based upon 21 cases collected from hospital records, where sufficient clinical data warranted consideration. The relative frequency of primary carcinoma as compared to other soft tissue tumors of the extremities is shown in Table I.

TABLE I

Lipoma	54%
Fibroma (including so called fibrolipoma)	12%
Hæmangioma	10%
Tumors of nerve sheath origin (neurofibrosarcoma)	8%
Fibrosarcoma	8%
Primary carcinoma	5%
Xanthoma	3%

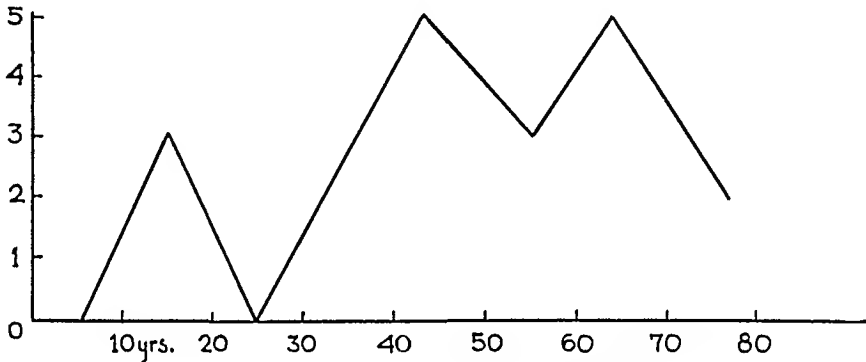
Showing percentages of occurrence of various types of tumors in extremities in a series of 300 cases.

Of the many histologic elements which go to make up a human limb, only the skin can be the point of origin for primary carcinoma. The other tissues are all of mesodermal or endodermal origin, with the exception, of course, of the nerve fiber, but this is a cellular process, or axone, whose cellular elements lie within or adjacent to the spinal cord. Hence, primary carcinomata of the extremities are epitheliomata. Three types are distinguished: squamous cell, basal cell, and melanotic carcinoma. The first is derived from the cellular stroma of the dermis; the second, which includes the rodent ulcer type, from the basal layer cells of the corium, hair follicles, sweat and sebaceous glands; the third, from pigment containing cells. Each of these types possesses clinical as well as pathologic characteristics. The last of these, melanocarcinomata, are considered rare. This may be true in reference to the body as a whole, since epitheliomata of all types are far more common about the face and neck

than on the extremities. However, in our series two were melanotic, so that, until further case groups are collected, we must assume that in primary carcinoma of the extremities about 10 per cent may be melanotic. This is of utmost importance since of the three types the melanotic is the only one which possesses a high grade of malignancy. Of the remaining cases, six were classified as basal cell, four as squamous cell, and nine were unclassified other than being epitheliomata. The frequent inability to differentiate the two types of nonpigmented epitheliomata was also noted by De Asis.

Sex.—Eleven cases occurred in males and ten in females. In previous reports, males were said to predominate (Broders,³ four to one, De Asis, 12 to five). In view of our own series, it appears that this predominance may be far less marked.

Etiology.—In no other soft tissue tumor of the extremity is the relationship between trauma and tumor so evident as in primary carcinoma. This trauma may be direct, following a crushing injury; or indirect, for example,



GRAPH 1.—Showing age group frequency.

developing within the scar of an old burn or other irritative lesion. Ullman⁴ noted that 80 per cent of skin carcinomata found associated with scars occurred in the scars of burns. In our series this figure was not even approached, only two of five scar epitheliomata having followed burns (40 per cent). Infection occurring in old operative scars was of equal etiologic importance.

The association of these neoplasms with ulcers must be noted. In 12 of the cases ulceration was present. In some the ulcer was of such long duration and so obviously the result of infection or trauma that it could with reasonable certainty be considered primary and the carcinoma secondary to it. In other of the cases, however, the tumor was probably primary in an infected sinus or unepithelialized portion of a scar, and subsequently became itself ulcerated. In at least three of the cases the ulcer represented the tumor as an uncompleted phenomenon forming a fungating mass. To differentiate these instances is speculative and of academic interest only. Suffice it to emphasize the frequency of association between primary carcinoma of the extremities and ulcer. In none of the cases was the ulcer of varicose origin.

Age of Onset.—This ranged from 13 to 73 years (Graph 1). The three cases which occurred under 20 years of age each presented unusual features. Case I was considered a naevocarcinoma of the pigmented variety,

i.e., melanocarcinoma. Case VIII was a squamous cell carcinoma occurring in the stump of a limb amputated following the prolonged treatment of an infected scar from a severe burn sustained in early childhood. Case XIII was diagnosed as an epithelioma (unclassified), excised following ineffective radiation. Excluding these three cases the others fell into the cancer age span, over 30 years.

Duration.—The average duration of original tumors, where this could be clearly determined, was 3.2 years. However, in many instances, the time of onset could not be determined because of a complex history of recurrent ulceration in a scar or wound.

Location.—Because of its association with scars, ulcers and trauma noted above, there is no usual site of predilection for primary carcinoma as there is for most of the other common soft tissue tumors of the extremities. Of the four cases involving the upper extremity, two occurred on the forearm, one on the hand, and one on a finger. Of the 17 cases involving the lower extremity, six occurred on the thigh, four each on the foot and leg, and three on the toes. The preponderance of lower extremity cases merely marks the greater frequency of trauma and infection on the lower as compared to the upper extremity.

Pain.—An important diagnostic characteristic of these tumors is the occurrence of pain, which often is the occasion for renewed interest in an old "weeping" scar or neglected sore. We have pointed out elsewhere that among the soft tissue sarcomata of the extremities pain is rarely a prominent symptom.^{5, 6} Only in the active stage of neurofibrosarcoma is the pain comparable in severity to that of carcinoma.⁷ It should become a surgical axiom that the appearance of pain in an ulcer or sinus after a period of apparent quiescence marks the onset of malignancy until proven otherwise by careful biopsy.

Physical Characteristics.—When the tumor presents as a palpable nodule, it is of stony hard consistency. However, as noted above, it more often appears as a diffuse, amorphous mass, frequently fungating or ulcerous, and then its consistency is indistinguishable from the host tissue. Its size varies from that of a pea to a grapefruit, but ordinarily attains the diameter of a half dollar, or the size of a walnut.

Metastasis.—Of the malignant soft tissue tumors of the extremities, carcinoma is the only one which metastasizes by way of the regional lymphatics⁸ (there are a few very rare exceptions to this). Hence, to all practical purposes, a palpable inguinal or axillary node in the presence of a soft tissue tumor of the extremity is pathognomonic of carcinoma. For the most part primary carcinoma of an extremity is of low grade malignancy and does not metastasize rapidly. The average duration of the lesion before admission (3.2 years), attests to this fact. In many instances metastases occurred only after a long period of hesitant and ineffective treatment.

Recurrence.—In five of the present series (24 per cent), a definite history of recurrence was established. This figure is subject to considerable theoretical modification. In several additional cases it could not be definitely de-

TABLE II

ANALYSIS OF 21 CASES OF PRIMARY CARCINOMA OF THE EXTREMITIES										
Diagnosis	Location	Sex	Age	Duration	Size	Pain	Palpation	Tissue of Origin	Treatment	Remarks
1. Carcinoma, probably naevo	Outer, lower $\frac{2}{3}$ Thigh	M.	20	7 yrs.	Grapefruit	No	Hard mass (ne-crotic)	Deep structures of corium	Excision and roentgen ray	Thought at first to be fibrosarcoma; recurrence $1\frac{1}{2}$ yrs. later with metastasis to lymph nodes, proved to be carcinoma
2. Carcinoma, basal cell	In scar of burn sustained in childhood	F.	55	Original tumor 2 yrs. Recurrence 7 mos.	Plum	No	Fluctuant	Scar (burn)	Original roentgen ray followed by excision. Recurrence excised	Recurrence; ulcerated
3. Melanocarcinoma.	Big toe	M.	55	7 yrs.		Yes		Crushed tissue —amputation stump		Toe had been amputated 7 yrs. after crushing injury; followed by radium without relief. Ulcerated 3 yrs. after amputation (present admission) metastases were found in groin
4. Carcinoma,.....	Anterior, upper $\frac{1}{3}$ leg	F.	35	4 mos.	Pea	No		Skin	Radium	Ulcerated
5. Carcinoma, basal cell	Upper $\frac{1}{3}$ thigh	M.	68	1.5 yrs.	Plum	No	Hard	Skin	Radium and excision	Ulcerated; regional nodes involved
6. Carcinoma, squamous cell	Anterior surface, knee	M.	73	2 yrs.	Grape	Yes	Hard	Skin	Radiation. Oper. refused	In scar of old infected operative wound; ulcerated—fungating mass
7. Carcinoma,.....	Anterior, middle $\frac{1}{3}$ leg	M.	67	14 yrs.	Plum	Yes		Skin	Excised	In scar of wound sustained at age of 20 ulcerated. Excised at 53—healed. Recurred
8. Carcinoma, squamous cell	Thigh, amputation stump	M.	20	1 yr.				Scar of stump	Excision —reamputation	Burned knee at 6 yrs. Infected —ulcerated. Amputated at 19 yrs. Ulcer reappeared
9. Carcinoma, basal cell	Inner, lower $\frac{1}{3}$ thigh	F.	52	3 yrs.	Plum			Skin	Excised	Ulcerated
10. Carcinoma, squamous cell	Heel	F.	63	1 yr.				Skin	Excised	Started as "pimple"; infected; ulcerated
11. Carcinoma,.....	Thigh	F.	54					Skin	Excision radiation	Below groin
12. Carcinoma,.....	Plantar surface foot	M.	22	3 yrs.		Yes	Hard	Skin	Excision radiation	Radiation ineffective
13. Carcinoma,.....	Forearm, anterior	M.	70	10 d. (?)		Yes	Hard	Skin	Excision radiation	Refused treatment
14. Carcinoma, squamous cell	Legs, bilateral anterior surfaces	M.	67	20 yrs.				Skin	Excision radiation	Recurrent ulcers
15. Carcinoma, basal cell	Toe	F.	39	1 yr.	Grape	Yes		Skin	Excision	
16. Carcinoma, basal cell	Finger	F.	65	2 yrs.				Skin	Excised	
17. Carcinoma,.....	Heel	M.	49	8 yrs.	$\frac{1}{2}$ dollar			Skin	Excised	Ulcerated
18. Carcinoma, basal cell	Foot, plantar surface	F.	77	4 yrs.	Walnut	Yes		Skin	Radiation 10 mos. ago	One wk. before admission; metastases noted at groin
19. Carcinoma,.....	Upper, inner thigh	F.	60	2 yrs.				Skin		Ulcerated; had previously been treated by roentgen ray and radium
20. Carcinoma,.....	Hand	F.	70	9 mos.				Skin	Amputation	Site of congenital contracture of index finger; ulcerated
21. Carcinoma, squamous cell	Toe	M.	38	1 mo. (?)				Skin	Elect. coag.	Developed after using corn plaster for several months

terminated whether a recurrence had occurred or merely a continuation of an insufficiently treated original lesion. Since probability in these cases favored the latter belief, they were not included among the recurrences. On the other hand, several of the recurrent cases had been treated with radium or roentgen ray and declared cured at the time. This was of course an arbitrary assumption. Since both of these exceptions are statistically mutually antagonistic, the established figure for recurrence, 24 per cent, may be assumed to come within a reasonable margin of error (Table II).

Treatment.—This has been for the most part unsatisfactory. Too often in the history of these cases there was noted long and varied local treatments in the form of medical applications or cauterizing measures to ulcerating tissues. This, it must be assumed, was due to false diagnosis, and could have been avoided by biopsy. While radiation has been the treatment of choice in most clinics, and, with recent improvement in technic,⁹ will no doubt become increasingly efficient, it has been far from uniformly successful. In six cases, including basal and squamous cell tumors, where radium or deep roentgen ray therapy had been used, the progress of the neoplasm was not averted. On the basis of present observations, the following procedures must be considered advisable.

(1) In primary carcinoma involving the digits, amputation of the digit should be performed without hesitation, followed by radiation of the adjacent tissue and regional lymph nodes.

(2) In primary carcinoma of other parts of the extremities, either wide excision of the tumor including adjacent host tissue, or amputation, followed by properly conducted radiation, should be instituted, including the local area and regional nodes. Whether wide excision or amputation is chosen depends entirely upon the grade of malignancy of the tumor. This must be determined by the history of the case plus biopsy, rather than biopsy alone, since basal cell carcinoma frequently presents a microscopic appearance of indolence in spite of obvious rapid growth clinically.

(3) Melanocarcinoma necessitates immediate amputation and radiation of the regional lymph nodes, but with a guarded prognosis at best.

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ELECTROSURGERY IN ADVANCED CARCINOMA *

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MANY cancer patients who come for treatment are in such advanced stages that they are pronounced inoperable by the ordinary surgical methods. Should roentgen ray and radium therapy fail to arrest the disease, they are usually considered to be beyond all hope of aid. However, among these patients there are many for whom electrosurgery may still furnish good, and frequently lasting, palliative results of even five years' arrest. Keysser,¹ in 1933, at the Cancer Congress in Madrid, reported 17.2 per cent of five year cures.

Electrosurgery, in our experience, appears to be the most effective method of treating ulcerated, secondarily infected carcinomata of the body surface and cavities. The experiences of Clark, Wyeth,² Keysser,³ Seeman,⁴ Ward⁵ and others have established the efficacy of electrical procedures in the fight against cancer. Among its special advantages is the minimal blood loss during operation, an especially important factor in the patient weakened by cancer. Moreover, the destruction of infected areas by carbonization and their fixation by coagulation minimizes the likelihood of generalized infection. Another advantage is the rendering sterile of the operated area for cancerous cells and microorganisms, for which reason a plastic operation may be done with greater safety at the same time. The operative dissemination of tumor cells is reduced because the electric cutting process destroys the cancer cells.

During the operation it is possible to recognize and to follow the cancerous tissues wherever they extend grossly, because the coagulated tumor tissues present a different color and consistency easily recognized by the experienced operator. Hence, the macroscopic extent of tumor may be determined with greater certitude than when operation is done with the scalpel. If the wound is left open the coagulated tissues form a protective layer over the deeper tissues against outside irritations and bacterial invasion, provided a sterile technic is employed in the after care. This facilitates multiple stage operations if the extent of the tumor or the patient's condition forbids a one stage procedure.

Electrosurgery and irradiation therapy in combination often afford a more favorable result than either method alone. Following the removal of a bulky infected tumor a more effective use of the resources of radiation is made possible.

Our experiments on rats with sarcomata and Flexner carcinomata seem to indicate that coagulation of these tumors, even if in sudden ebullition the tissues explode, does not cause distant metastasis any more frequently than

* Read before the New York Surgical Society, March 27, 1935.

occurs in control animals. Furthermore, we could not experimentally affirm the clinical observation that the absorption of coagulated tumor tissue favorably influences the regression of other tumor rests. However, in spite of the fact that the latter hope does not seem to be fulfilled by electrosurgery, the method has certain undeniable advantages. We have used this procedure on a large number of cases in the Skin and Cancer Unit of the New York Post-Graduate Hospital with only 3 per cent immediate postoperative mortality.

Although the operation was extensive in many instances there was no postoperative shock. Moreover, during convalescence there was relatively so little pain that many of the patients did not require narcotics.

Electrosurgery is not a shocking procedure and is well borne even by the cachectic patient. It is, therefore, a most effective palliative measure to prolong life and give comfort even to patients presenting distant metastases.

Four cases treated by electrosurgery alone are presented. They are representative of four types of procedure and demonstrate that electrosurgery can still give relief in cases which, by ordinary criteria, would seem to be hopeless.

ILLUSTRATIVE CASE REPORTS

CASE I.—Advanced squamous cell carcinoma of the tongue (No. 31-2247. Path. No. 15,755). This patient, a white male, 79 years of age, came to Stuyvesant Square Hospital presenting an extensive hard mass on the left side of his tongue measuring 3 by 2 cm. which he had noticed about four months previously (Fig. 1). The pathologic report was squamous cell carcinoma.

A year and a half before the patient came to us, he had been treated by implantation of radium needles. Although a total dose of 968 mgh. was followed by slight improvement, the tumor persisted, increased in size, and became painful. On examination the patient was in poor condition. Red blood cell count, 1,600,000. There was leukoplakia over the anterior third and an ulcerated, firm area about one inch in diameter at the left side of the tongue, the lesion extending towards the midline and towards the base of the tongue. No submaxillary nodes were palpable.

Under local novocain anesthesia, the lesion was removed electrosurgically, following the tumor step by step, with a minimum loss of blood. The freshened wound edges were approximated by sutures. Primary union resulted with a small discharging sinus at the base of the tongue which healed in two weeks. Under appropriate treatment, the red blood cells increased in a few months to 4,000,000. Then the patient discontinued his medication and his red cell count has fallen to 2,500,000.

In spite of a low blood count, cachexia, and advanced age, this patient not only stood the mild electrosurgical procedure very well but made a quick recovery. By the routine surgical procedure extirpation of the tongue might have been indicated. The electric procedure, at first glance, appeared to be too conservative. However, the involved area was destroyed by coagulation, followed by its removal with the electric loop with a wide margin of healthy tissue. The cancerous tissue following coagulation was so distinctive in appearance and consistency that one could readily recognize the limits of the tumor and differentiate it from the normal tongue, which permitted us to save the tip of the tongue with ultimate good functional palliative results (Fig. 2). Although 11 months have passed since operation, there has been neither local nor regional recurrence.

This case is an example of the removal of the coagulated tumor masses followed by primary union of the wound edges.

CASE II.—*Extensive recurrent carcinoma (Grade 2) of the right chest wall* (No. 34-1359. Path. No. L9703-19906). Seven years ago this patient, a white female, 53 years of age, had a radical operation for tumor of the left breast. Four years later several small lumps appeared in the right chest wall. These could not be controlled by roentgen ray treatment and the patient was rapidly failing.

When she came under our care the entire right chest wall was covered with raised, red, firm, easily bleeding, partly ulcerated nodules. There was confluent, foul ulceration at the right side, the nodules being attached to the skin and underlying tissues over an area 8 by 10 inches. There were also numerous pink firm nodules on the left breast and right scapula. In the supraclavicular regions, slightly movable tumor masses could be palpated. Many firm nodes could also be felt in the cervical region, up to the angle of the jaw (Fig. 3).



FIG 1.—(Case 31-2247) Squamous cell carcinoma of the tongue before electro-surgical treatment.



FIG 2 —(Case 31-2247.) Squamous cell carcinoma of the tongue after electro-surgical treatment.

Under gas anesthesia, a partial cervical node dissection was done by electrosurgery. The lesions on the chest wall were removed by coagulation in four stages and the granulating wounds were Thiersch grafted. In spite of the large operative area, the patient stood the intervention very well.

This case illustrates the possibilities with electrosurgery, in cases where operative procedure would be difficult and radiation therapy a failure. It is 12 months since the original operation, but the patient has no pain or discomfort whatsoever and roentgenographic examination has not shown internal metastases. She is still under treatment and if new nodules appear in the skin they will be removed under local anesthesia (Fig. 4).

This patient represents a group of cases in whom electrocoagulation is followed by epidermis transplantation to the secondary granulating surface.



FIG. 3.—(Case 34-1359.) Extensive recurrent carcinoma of the right chest wall before electro-surgical treatment.



FIG. 4.—(Case 34-1359.) Extensive recurrent carcinoma of the chest wall after electro-surgical operations and Thiersch graft.

CASE III.—*Advanced carcinoma of the breast (adenocarcinoma Grade 2)* (No. 33-868. Path. No. 18718). A colored female, 75 years of age, first noticed a lump in her left breast four years ago. The lesion slowly increased in size and several months ago became ulcerated, discharging some blood.

When she came for treatment, her deformed left breast showed an oval, ulcerated, stony-hard mass, involving the entire outer quadrant. The tumor was attached to the surrounding tissues and underlying muscles. A few firm nodes were palpable in the axilla. Because of the advanced condition, operation was considered inadvisable. Palliative radium therapy, however, was administered for two months, totalling 2,912 mgh., with some improvement. Electrocoagulation was then advised for the persistent tumor.

The patient presented a foul, sloughing, secondarily infected mass (Fig. 5), involving the whole upper outer quadrant of the breast and destroying the nipple. Scattered about the tumor were secondary areas of skin involvement. The primary tumor and the other involved areas were gradually eliminated by being first coagulated, then removed by the electric loop in order to sterilize the operative field. After another



FIG 5—(No. 33-868.) Advanced carcinoma of the left breast before electro-surgical operation and application of radium.



FIG 6—(No. 33-868.) Advanced carcinoma of the left breast after electro-surgical removal of growth and plastic operation.

preparation of the patient, the pectoralis muscles were partially resected and the axilla cleaned. The involved periosteum and intercostal muscle were superficially coagulated and carbonized. The area was covered with a skin flap measuring about five by nine inches, taken from the epigastric region, and after a drain was inserted, the wound was sutured (Fig. 6). The patient made an uneventful recovery except for a small area of necrosis of the skin flap which healed with secondary granulations.

This case illustrates the good result that may be achieved by electro-surgical methods in a case of far advanced, ulcerated, infected cancer of the breast when followed by an immediate plastic operation on the coagulated area, resulting in undisturbed healing. It demonstrates further the possibility of worthwhile palliation in a case ordinarily regarded as hopeless. In spite of the advanced lesion and the skin metastases, the patient is well, without evidence of local or regional recurrence 16 months after the plastic operation following sterilization of the infected area by electro-surgery.

CASE IV.—*Advanced squamous cell epithelioma (Grade 2) of the forehead* (No. 33-480. Path. No. 17751-17985-18033). A white female, 74 years of age, came to Stuy-

vesant Square Hospital with a history of "black spots" on her face for the last 18 to 20 years. One year ago a growth appeared on the right side of the forehead, rapidly increasing in size and gradually becoming painful.

Because of the patient's poor general condition—she had lost considerable weight—operation was not advised and a total of 160 mgh. of radium was administered by the insertion of platinum needles. Although there was slight improvement during the next two months, the frontal lesion persisted.

Physical examination revealed a poorly nourished, pale woman with chronic bronchitis. Red blood cell count, 3,460,000. The entire face was covered with hyperkeratotic areas. On the right side of the forehead there was an elevated, ulcerated, easily bleeding, necrotic mass two and one-half inches in diameter, surrounded by inflamed skin (Fig. 7). Roentgen examination showed that the lesion was attached to the underlying periosteum invading the frontal bone.



FIG. 7.—(Case 33-480.) Squamous cell carcinoma of the forehead and hyperkeratosis of the face before electrosurgical treatment.



FIG. 8.—(Case 33-480.) Squamous cell carcinoma of the forehead and hyperkeratosis of the face after electrosurgical treatment.

The cancerous area was coagulated and removed (Fig. 8). The frontal sinuses were opened and cleaned out. The right frontal sinus showed cancerous involvement. This was coagulated and removed. The wound was packed with vaseline gauze. The patient's temperature was slightly elevated the first few days, but she remained in good condition and had no pain. The wound was clean after ten days, granulating except for the coagulated bone tissues. After three weeks there were healthy granulations with the exception of bone sequestration. There was no evidence of recurrence. Plastic operation* was performed after the necrotic bone was chiseled away. The wound edges were freshened and covered by two winged flaps, prepared from the front and united in the midline. A drain was inserted under the flap through the nose. The area

* The author wishes to thank Dr. Gustav Aufrecht for his valuable advice concerning the plastic procedure.

from which the skin flaps were prepared was covered with Thiersch graft from the leg. Two days later the drain was removed and undisturbed healing took place.

Three months later we carried out electrosurgical treatment of the extensive hyperkeratotic areas. A new growth, also, was removed from the left eyebrow. Healing occurred with slight secondary infection and resulted in smooth, soft scars.

Judged by ordinary standards of radiology and surgery, this patient would have been considered a hopeless case, nevertheless, a worthwhile degree of palliation has been obtained in a relatively short time by electrosurgery. Twenty months have elapsed since operation and she is well, without evidence of either local or regional recurrence.

This patient represents a fourth group of cases in whom a secondary plastic operation is done following the original electrosurgery, at the indicated time (which is at least three to six months later), according to the type of tumor, unless there is indication for an earlier closure.

SUMMARY

Although a permanent cure may not be possible in many of the far advanced cases, patients may benefit by the amelioration of pain and by the elimination of a sloughing ulcerated carcinoma, which is very important not only from the individual but also from the social point of view.

Having had the opportunity to operate on a large number of advanced carcinomata in the New York Skin and Cancer Hospital, using the electrosurgical procedures described, we have been impressed by the relatively simple and mild character of the operation and its lower mortality. Patients are temporarily benefited even when distant metastases are present. Cachectic patients may be relieved of pains and the infected necrotic areas are eliminated. The four cases reported have demonstrated the palliative results following four different types of procedure.

The author wishes to express his appreciation to Dr. Henry H. M. Lyle and to Dr. Carl Eggers for their cooperation and the encouragement shown to him in this work.

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LEPTOTHRICOSIS

PULMONARY ABSCESS AND FATAL PYEMIA

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HUMAN infection from the filamentous forms of the high bacteria is rare and principally due to the actinomyces. The existing chaos regarding the whole subject of the higher bacteria is well shown by the many classifications which have been advanced.^{1, 2, 3, 4} Mackenzie's classification is probably the most practical⁵:

CLASSIFICATION OF HIGHER BACTERIA (Mackenzie)

- A. Typically filamentous forms..... Actinomycetaceae
- B. Mycelium and conidia formed..... Actinomyces
- BB. No true mycelium
 - C. Cells show branching
 - D. Gram-negative Actinobacillus
 - DD. Gram-positive Erysipelothrix
 - CC. Cells never branch: gram-positive: threads
later fragmenting into rods..... Leptothrix

A review of the literature on leptothrix infection shows it to be very rarely pathogenic for man; indeed, a surprising number of authorities^{2, 3, 4, 13, 14} consider it non-pathogenic. Mackenzie⁵ states that: "The great mass of bacteriologic literature is concerned with the species which inhabit the mouth and adjacent ducts and cavities: clinical and pathologic observations are related, as a rule, to diseases of the mouth and sporadic and unusual cases of meningitis, many or most of which are probably the result of infection by a variant of the bacillus of influenza." Harris⁶ has recently reviewed the literature, collected five cases of severe human leptothrix infection, and emphasized its rarity. Two other reports^{11, 12} are herein added to Harris' collection:

Author	Location
Harris ⁶	Liver—multiple abscesses
Deussing ⁷	Upper respiratory: kidney
Roedelius and Braek ⁸	Upper respiratory: kidney
Von Meyenburg ⁹	Liver
Lang ¹⁰	Liver
Diek, Diek, and Rappaport ¹¹	Kidney
Thjotta ¹²	Lung: bone

CASE REPORT

Hartford Hospital History No. 250004.—T. N., male, 23 years old, steelworker, was admitted June 20, 1931, complaining of cough and foul sputum of six months' duration. In October, 1930, he had been in an automobile accident suffering fractures

of both femurs and the right mandible. December 24, 1930, three weeks prior to the onset of cough, he had been a patient at the Norwegian Lutheran Deaconesses' Home and Hospital in Brooklyn, New York, where an abscess of the right jaw was incised and drained. Four days later he was discharged. There were no subsequent jaw symptoms. During the next three months he lost weight and strength, and the cough became productive of increasingly large amounts of sputum. Three months of hospitalization followed, during which time he received postural drainage and vaccine treatment for lung abscess. Two massive hemorrhages occurred during this period and at admission to the Hartford Hospital he was raising 500 cc of thick, foul, greenish sputum daily and had lost 11 Kg. in weight.



FIG 1.—Right lung, pleural thickening with drained abscess lower lobe.



FIG 2.—Cut section of right lung* multiple abscess cavities

Examination showed a moderately emaciated white male with a distressing foul productive cough, evidence of anemia, clubbing of the fingers, and signs of abscess of the right lung. Roentgenograms revealed multiple lung abscesses with associated pleural exudate on the right. Sputum examination showed mixed flora with no tubercle bacilli, no leptothrix reported. Blood studies substantiated the anemia; stool and urine examinations were not remarkable.

Two weeks after admission, under novocain anesthesia, rib resection was done and through an adherent pleura a large abscess cavity was deroofed and packed with gauze. Unfortunately, no culture was taken. Some improvement followed but he gradually failed despite blood transfusions and other supportive treatment. Six weeks after

thoracotomy signs of right psoas irritation were found. A large retroperitoneal abscess in the right perinephric region was drained, cultures showing a leptothrix in pure culture. Dextrose broth demonstrated long filamentous forms of bacteria with no branching. No growth was obtained on blood agar, aerobically or with reduced oxygen tension, or on anaerobic banana broth. The organism was recovered from an inoculated mouse but could not be subcultured. A few days later an abscess in the right forearm was evacuated, a similar leptothrix being obtained which, however, would not grow on blood agar, banana broth, or deep dextrose agar. Inoculation showed it non-pathogenic for mice. The subsequent course was one of gradual failure, with increasing emaciation, and death December 13, 1931, 11 months after onset.

Postmortem Examination by Dr. W. M. Allen.—*Gross Description*.—Adult white man of about 25 years showing marked emaciation. Small shotty nodes palpable in neck, axillae, and inguinal regions. Open surgical incisions in the lower midaxilla and in the posterior axillary line on the right, the first extending simply into the subcutaneous tissue to an irregular abscess cavity about 5 by 3 cm., the latter through partial resection of the ninth rib into the pleural cavity. A small sinus tract on the volar surface of the right forearm with an underlying cavity containing a small amount of exudate.

Thorax: Right pleura practically obliterated by rather dense fibrous adhesions. A small ragged abscess cavity in the region of the thoracotomy, with no demonstrable communication with a bronchus. Right lung: 720 Gm. (Fig. 1). On section (Fig. 2) the entire lung riddled with cavities 1 to 2 cm. in diameter, angulated and elongated and showing a fairly marked interstitial fibrosis of the cavity walls with surrounding grayish consolidation. Purulent material in the bronchi, the mucosa of which is hyperemic. Bronchi in many cases seen running into abscess cavities. Left lung: 620 Gm., with no adhesions or cavitation but showing a number of barely palpable dark red areas of apparent consolidation, more marked in the lower lobe, with the appearance of ordinary lobular pneumonia. Mediastinal and peribronchial nodes on the right, moderately enlarged, homogeneous, and without abscess formation.

Abdomen: Ascites slight. Liver: 3,400 Gm., enlarged downward to the umbilicus and with adherent omentum in a number of areas. Bulging abscesses under the surface (Fig. 3), many almost perforating. Liver on section (Fig. 4), riddled with large irregularly shaped abscesses up to 6 cm. in diameter, filled with thick grayish pus, and with only slight fibrosis of the walls. The surrounding liver substance hyperemic, but the remainder of the liver parenchyma essentially normal. Spleen: 380 Gm., slightly softened, and of ordinary appearance except for abscesses about 2 cm. in diameter in the lower pole, similar to those found in the liver, and some apparently having broken through to form an abscess surrounding the lower pole of the spleen and the splenic flexure of the colon. Kidney: 400 Gm., cortex not sharply limited. Adrenals: diffuse induration without abscess formation. Abdominal lymph nodes: slightly enlarged, of homogeneous pale-buff color and without abscesses or granulomata.

Microscopic Description.—Heart: moderate cloudy swelling without inflammatory reaction. Right lung: abscesses of every size in various stages of development, most of them fairly chronic with some fibrosis of the walls and showing very considerable tissue destruction. The cellular exudate, at least one half of the mononuclear type, i.e. lymphocytes, plasma cells, and macrophages. Small irregular particles of amorphous material in the center of the abscesses. Left lung: essentially a bronchiopneumonic type of lesion, although here, too, exudate largely mononuclear with some early tissue necrosis, possibly representing an earlier stage of the process seen elsewhere. Lymph nodes: considerably hypertrophied, with loss of follicular arrangement but without abscess formation. Splenic abscess: entirely similar to those in the lungs. Liver: very little fibrosis in the walls of the abscesses, the uninvolved areas showing considerable cloudy swelling and fatty degeneration. Kidneys: essentially normal. Adrenals: congested and edematous but structurally intact.

Bacteriology and Animal Inoculation.—Direct smears from the liver abscesses

FIG. 3.—Superior aspect of liver: multiple bulging abscesses.



FIG. 4.—Cut section of liver: multiple abscess cavities.



showed masses of gram-negative bacillary forms, many small and slender; numerous fairly large fusiform shaped organisms; fairly numerous irregularly staining long slender filamentous forms. Blood agar plates remained sterile. Banana broth grew a gram-negative bacillus on the second day, on the fifth day some gram-positive bacilli occasionally in long forms were found, and on the eighth day some gram-positive bacillary forms and some long thin leptothrix-like organisms were isolated. Subcultures produced no growth. Prolonged microscopic study of numerous sections, including bacterial stains of the tissues, revealed no definite fungi.

Two cc. of the purulent material from a liver abscess were mixed with 10 cc. of infusion agar at body temperature and injected into a rabbit, 3 cc. into pleural and peritoneal cavities, and 1 cc. subcutaneously into the back and right side. One cc. of the unmixed pus was injected into the left side. The rabbit lived two months and autopsy showed a very extensive foul subcutaneous purulent infection burrowing into the inguinal regions. No abscesses or agar masses could be found in the peritoneal or pleural cavities, and no organism could be demonstrated or cultured from the foul abscess material. A guinea pig was injected with 0.5 cc. of the pus mixture into the pleural and peritoneal cavities. The guinea pig lived six months and at autopsy showed no sign of infection and no organisms.

*Postmortem Diagnosis.*¹⁵—Abscess of lung, right, due to actinomyces (leptotrichia) 360-202.2. Empyema, right 370-202. Generalized actinomycosis (leptothricosis) 012-202.

DISCUSSION.—Bacteriologic studies are so varied that a complete review of the subject of the higher bacteria would serve to confuse the picture. The work of Mackenzie,⁵ Wherry and Oliver,¹⁶ Bulleid,¹⁷ and Harris,⁶ are worthy of note. The essential characteristics are that the leptothrix is an unbranched filamentous bacterium of the Actinomycetaceae group, varying in its staining qualities, difficult of culture, and rapidly losing its pathogenicity in successive animal inoculations.

Sufficient cases have not been reported to warrant any conclusions as to the value of forms of therapy other than that of any pyogenic infection. Dick, Dick, and Rappaport¹¹ report favorable results from the use of vaccine. Page,¹⁸ in studying streptothrix infections, found vaccines of little value. Wangenstein¹⁹ has recently cast considerable doubt on the value of the iodides and roentgen ray therapy in the treatment of infections due to the actinomyces. Graham,²⁰ in his recent text-book, does not include the treatment of leptothrix infections *per se* but summarizes the treatment of actinomycosis as follows: "Most of the successful treatments have included massive doses of iodides, roentgen ray therapy, surgical attack and autogenous vaccines. In several cases all three plans of treatment have been used." From available reports there is little uniform enthusiasm for any form of treatment except as an adjunct to surgery.

SUMMARY AND CONCLUSIONS

(1) Fatal leptothrix infection is exceedingly rare, as shown by a review of the literature.

(2) A case report with autopsy findings of lung abscess and metastatic abscesses of the spleen, liver, retroperitoneal tissues and forearm is presented.

(3) The finding of pure cultures of leptothrix in the drained retroperi-

toneal and forearm abscesses, and the obtaining of leptothrix from culture from the liver abscesses postmortem, warrants the diagnosis of leptothricosis.

(4) Treatment is that of any pyemic infection. Roentgen ray, vaccine, and iodide therapy have no proven value in leptothrix infection, but experiences in the treatment of infections with the other higher bacteria suggest further trial of these measures.

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FRACTURES OF THE JAW AND ALLIED TRAUMATIC LESIONS OF THE FACIAL STRUCTURES

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"SURGERY to-day is being practiced by too many light-hearted and incompetent surgeons," says Sir Berkeley Moynihan.⁸ Not infrequently jaw fractures and associated injuries of the bones of the face result in permanent displacement and deformity. The importance of reducing these fractures from a functional and from a cosmetic viewpoint is obvious. It is the duty of the surgeon with his knowledge of the mechanics and of the reactions of the tissues involved to prevent or, at least, to minimize these deformities. Extensive hospital experience with this type of work is unquestionably of the utmost value. While the specially trained oral and orthopedic surgeon is best fitted to handle these cases, accompanying crushing facial injuries involving vessels, nerves and muscles may present problems requiring the cooperation of the otolaryngologist, the plastic surgeon and the neurosurgeon. As a consequence, no doubt, of this mad machine age, the increasing number of these serious facial injuries demands a careful consideration of the methods which constitute the most satisfactory forms of treatment.

Location of Fracture.—When considering the location of fractures, we find that the rami, condyles and coronoid processes, protected somewhat by their anatomic placement, are less frequently broken, while the vulnerable position of the mandible causes its involvement in a very large percentage of facial injuries. The point of fracture is determined not only by the strength and thickness of bone but by the direction from which the traumatizing blow is received. In the inferior maxilla we find the symphysis to be the strongest portion, the mental foramen, the weakest, and the angle, though heavy and apparently resistant to trauma, to be one of the most frequent points of fracture.

Reduction Method.—The voluminous literature on the subject of jaw fractures covering, as it does, many and varied types of technic and treatment, shows plainly the lack of uniformity of opinion. Effective measures and devices have been originated or modified by G. V. I. Brown, G. M. Dorrance, H. S. Dunning, T. L. Gilmer, V. H. Kazanjian, Chalmers Lyons, Sterling Mead, F. B. Moorehead, R. T. Oliver, Kurt Thoma, and Leo Winter. It was Doctor Gilmer³ who pointed out the value of wiring the mandibular teeth to those in the superior maxilla for fixation in fractures of the mandible. Ivy and Curtis⁴ describe a modification which they consider superior since it permits a greater degree of accessibility to the mouth for replacement of a broken wire, *etc.*, without disturbing the main attachments on the teeth. From per-

sonal experience, we consider that our results from the use of the Ivy-Curtis technic of eyelet wire fixation have been sufficiently favorable to warrant its uniform adoption.

SYNOPSIS OF CASE SERIES

TABLE I

GENERAL FEATURES—SIXTY CASES

Fracture Cases	No.	Per Cent
Sex		
Male.....	43	71.7
Female.....	17	28.3
Type		
Single (simple).....	7	11.7
Single (compound).....	35	58
Double (compound).....	15	25
Triple (compound).....	3	5
Site		
Through maxillary incisors.....	2	3.3
Depressed malar bone.....	6	10
Depressed zygomatic arch.....	3	5
Condylod process.....	4	6.7
Coronoid process.....	1	1.7
Ramus.....	2	3.3
Angle of mandible.....	15	25
Region of mandibular molars.....	20	33.3
Region of mandibular premolars.....	4	6.7
Median line of mandible.....	3	5

TABLE II

AGE DISTRIBUTION—SIXTY CASES

Fracture Cases	No.	Per Cent
10-19.....	10	16.7
20-29.....	22	36.7
30-39.....	12	20
40-49.....	9	15
50-59.....	4	6.7
60-69.....	2	3.3
70-79.....	1	1.7

TABLE III

CAUSES—SIXTY CASES

Fracture Cases	No.	Per Cent
Automobile accidents.....	36	60
Fights.....	21	35
Falls.....	2	3.3
Gunshot wound.....	1	1.7

Cause of Fractures.—In respect to the principal causes of mandibular fractures, we find that Dunning² quotes 55 per cent of 1,065 cases as having been due to assault and battery; in a series of 100 cases, Ivy and Curtis⁵

list 49 per cent under assault and battery; Winter,⁹ in a series of 200 cases, assigns 75 per cent to the same cause. In connection with our own series, the listing of automobile accidents as the most frequent causative factor seems somewhat at variance with the findings in eastern localities. We venture to suggest that the reason is to be found in the extensive automobile highways throughout the west and their too widespread use at dangerous rates of speed. On the other hand, the huge metropolis with its polyglot throngs would almost certainly have a preponderance of injuries actuated by the more usual forms of physical violence.

DIAGNOSIS.—A careful history as to the nature and time of the accident should be obtained. The diagnosis in jaw fractures presents no difficulty in the presence of abnormal and painful movement, displacement, loss of function, malocclusion of the teeth, and, most important of all, roentgenographic examination, at least two views. These are particularly valuable for showing the direction of fracture lines and the relationship of fragments and tooth roots. Further, the roentgenogram affords an indisputable record in medico-legal complications. According to Ivy and Curtis,⁴ "in every case of fracture in the region of the mental foramen, we should always look for a second fracture at the angle on the opposite side."

In a fracture through the neck of the condyle, or ramus, there is shortening of the distance from the angle to the glenoid fossa on the affected side, so that the mandible drifts to the opposite side causing the molars on the injured side to meet before those on the opposite arch. In fractures through the mental foramen, the anterior fragment is displaced or drawn downward by the action of the depressor muscles, while the posterior fragment is pulled upward by the masseter, temporal and internal pterygoid muscles. In a fracture through the angle, the lower end of the short fragment is generally displaced upward and forward by the contraction of the elevator muscles. The larger fragment frequently is drawn slightly toward the fractured side. In mandibular fractures, the displacement is contingent upon, and governed by, the action or interaction of the muscles to which the jaw gives attachment. We may add, too, that a comprehensive understanding of muscle function and control is of inestimable value.

TREATMENT.—While the slogan in every fracture case may be said to be "early fixation," mandibular fractures must sometimes prove an exception. Immobilization of the jaws should not be attempted until the general condition of the face and mouth is such that the fixation may have a reasonable expectancy of remaining in place. The factors to be considered at this time are: (1) edema of the soft parts; (2) mouth sepsis; (3) removal of carious roots and loosened teeth, especially along the line of fracture, with the attendant possibility of hemorrhage; and, (4) necessary attention to the remaining teeth from the standpoint of an additional source of infection.

In the presence of edema of the soft tissues, the application of hot and cold compresses is valuable. Preparatory to coaptation of the bony parts, the eradication of mouth sepsis cannot be stressed too strongly, since the end-

result is almost entirely dependent upon the degree of cleanliness that it has been possible to maintain in the mouth. The presence of carious teeth and roots, of course, constitute a bacterial menace which should be eliminated. However, the retention temporarily of a loose or decayed tooth may be justifiable in cases where a fragment would become edentulous by its removal.

Temporary Support.—Where immobilization had to be delayed, we found that a temporary head support or bandage not only gave the patient a sense of comfort and security but increased his willingness to cooperate. In using this support, the teeth are fixed in fairly good occlusion, a small abdominal

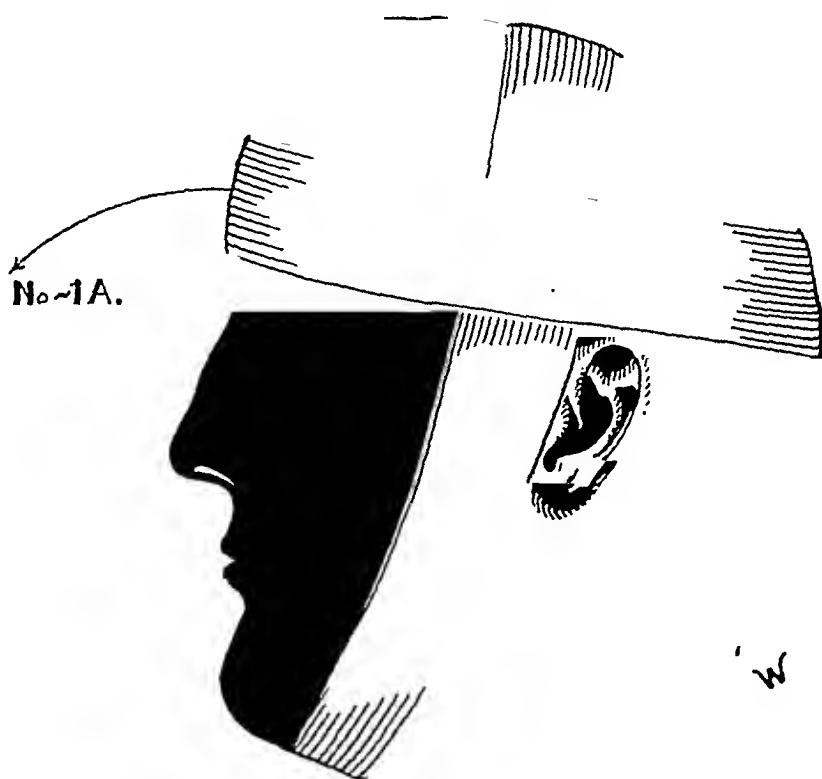


FIG. 1.—Modified Gibson bandage for support of fractured jaw.
1A.—Reversal of roller at left temple.

pad is placed under the chin, and, using two inch muslin, a modification of the Gibson bandage is applied. From the vertex of the skull the roller passes downward in front of the right ear, under the chin and up in front of the left ear to the starting point. This is repeated three times, then, at the left temple, the bandage is reversed and carried horizontally around the head three times. Adhesive strips, half an inch narrower than the bandage, are then placed over it (Fig. 1).

Immobilization Method.—Regardless of the situation in the jaw, about 90 per cent of mandibular fractures are reduced efficiently by the eyelet wire technic of fixation. We have already mentioned our preference for the Ivy-Curtis⁴ method which is, briefly: the teeth selected for wiring must be located opposite each other on the jaws; when available the premolars and

incisors are used. Six eyelets in pairs are used; these are made by taking six inch strands of No. 24 gauge soft brass wire, forming a small eyelet in the center of the strand and retaining it by a double twist. With the eyelet held on the buccal surface, the ends of the strands are passed between the teeth selected, bent in opposite directions, and fitted firmly and snugly around the teeth in order to hold the eyelet in a fixed position. All excess wire is cut off and the ends tipped with modeling compound to protect the mucosa. Through each of the three pairs of eyelets is passed a twelve inch strand of the same wire. The patient is asked to cooperate with the surgeon in bringing the jaws together as closely and naturally as possible. With the twisting and tightening of the three strands, complete immobilization is obtained (Fig. 2).

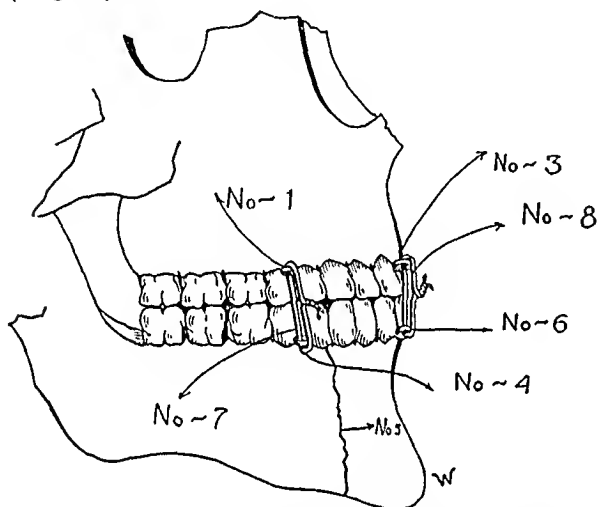


FIG. 2.—Teeth fixed in occlusion and jaws immobilized. Nos. 1, 3, 4, 6.—Eyelets. Nos. 7, 8.—Single tie wires through maxillary and mandibular eyelets. No. 5.—Line of fracture.

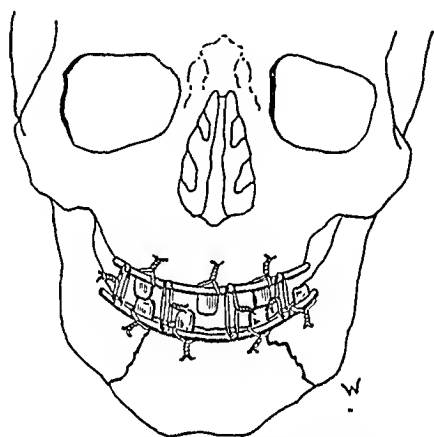


FIG. 3.—Fixation using modified half round arch bars (after Ivy-Curtis) where insufficient teeth prevent the use of eyelet technic.

General Considerations.—In the absence of opposing teeth suitable for eyelet fixation, we used half round arch bars (modified) as recommended by Ivy and Curtis⁴ (Fig. 3). We found it expedient to maintain the temporary support for approximately one week after fixation, removing it periodically for necessary facial hygiene. For irrigations of the oral cavity, we used Carrel-Dakin therapy and a saturated solution of sodium perborate alternately.

Duration of Fixation.—Definite periods for fixation cannot be established since accompanying factors are rarely if ever identical. However, in our uncomplicated single fractures, the average time for immobilization was three weeks; in double compound, uncomplicated fractures, thirty-two days. Fixation periods designated by other surgeons are: Dean,¹ 43 days; Ivy and Curtis,⁵ 31 days; Rogers,⁷ 28 days; Winter,⁹ 36 days. The same authors point out, though, that with complications the period may extend from nine to 18 weeks.

COMPLICATIONS.—The complications of jaw fractures are chiefly those of infection. Where a root or spicule of bone is present in the line of frac-

ture, it is advisable to provide external drainage at the time of immobilization (Fig. 4). Abscess formation is not unusual, and the pus often gravitates into the submaxillary, cervical or sublingual spaces. This is best drained by making a small incision through the most pendulous part of the mass, then, with a hemostat, doing blunt tunneling after the Hilton method. Consideration should be given to the cosmetic result, to the anatomic structure, and to the avoidance of traumatizing the bone. Very often this suppuration affects



FIG 4.—Example of detached spicule of bone in line of fracture. Failure to establish drainage resulted in bone destruction and delayed union.

only the soft tissues and will clear up promptly, but, should it persist unduly, osteomyelitis is indicated.

Osteomyelitis.—According to the literature, osteomyelitis is not an unusual complication in jaw fractures. This condition is suspected by constant and excruciating pain and is located definitely by gently tapping the affected bone. In the early stages, the roentgenogram is of little value since bone destruction does not occur for at least three weeks after infection. The

alveolar processes in an infected area usually undergo a degree of degeneration that affects the teeth. During the acute stage of the disease, many surgeons are emphatic in their protests against any form of operative procedure. Chiseling or curettement of the diseased parts not only destroys the growing bone tissue but endangers the nutrient artery. Exfoliation of sequestrum by natural processes, and its removal through the mouth when possible, will result most favorably. Hot wet local dressings should be used freely, as well as mouth irrigations of potassium permanganate (1:4,000), or Dakin's sodium hypochlorite solution. Maintenance of the patient's general condition should not be overlooked.

In our series of mandibular fractures, ten (all males) were complicated by infection, and six of these developed an osteomyelitis. In the subperiosteal abscess cases, healing and union required from 40 to 50 days, while those complicated by osteomyelitis needed from 65 to 90 days.

Malunion.—Late and improper treatment is nearly always responsible for this condition. Its most serious complications are malocclusion and dysfunction. Recourse to osteotomy is usually necessary for repair.

Delayed Union.—In delayed union we are confronted with an abnormal time element although union is constantly progressing. A factor may be a systemic calcium-phosphorous deficiency. Local treatment, especially in regard to the reposition of the fragments, seems the best stimulant for satisfactory union.

Non-union.—When, for any reason, normal osteogenesis is prevented, reparative processes cease. As far as we know, local causes of non-union are: suppurative processes, osteomyelitis and necrosis, traumatized blood supply, and too frequent manipulation of bony fragments; while general causes are: syphilis and tuberculosis, calcium-phosphorous deficiency, and age and general debility.

FRACTURES OF EDENTULOUS MANDIBLE.—In our own limited experience with this condition, we were able to utilize the artificial dentures of the patient, first reinforcing the alveolar ridges with impression compound. When the displacement of fragments is marked, Ivy and Curtis⁴ quote Black's suggestion of circumferential wiring of the bone.

FRACTURES OF THE NECK OF THE CONDYLE AND THE CORONOID PROCESS.—In five cases, we successfully employed the Ivy-Curtis eyelet wire fixation technic. Immobilization averaged three to four weeks. Our cases did not result in ankylosis to a point of fixation of the joint, and temporary stiffness was treated with massage and physiotherapy.

FRACTURES OF THE MAXILLA.—These fractures are usually the result of crushing facial blows that have injured adjacent structures at the same time. These complications, together with the delayed reduction of the fracture necessitated by them, may cause permanent facial deformities. The superior maxilla is not influenced by powerful muscle attachments that have a tendency to distort a fractured area, but lacerations and extensive edema may be considered a certainty, therefore roentgenologic study is invaluable.

Infection is not uncommon, but the rich blood supply to this region makes necrosis relatively rare. The fractured maxilla, being almost without exception merely one phase of the injury, must be considered from the viewpoint of the entire involvement in the matter of treatment.

FRACTURES OF THE MALAR BONE AND ZYGOMATIC ARCH.—Located so prominently, the malar bone and zygomatic arch assume a significant position among the bones of the face, particularly in regard to cosmesis. All of the facial structures are important, not alone through their external distinctness but because both they and their foramina, attachments, and borders involve an area of very complicated and vital structures. Fractures in this region, usually the result of extreme direct force, should be reduced as soon as possible, since delay increases the difficulty in approximating the bony parts.

In the determination of these fractures, the surgeon will obtain valuable aid from direct palpation both intra- and extrabuccal. The latter, in particular, is both simple and efficient for the zygomatic arch is readily palpated in the average person and even more clearly defined in those afflicted with any wasting disease.

Reduction Method.—Many and ingenious methods have appeared in the literature from time to time for the elevation of these fractures, one being a method originated by Matas.⁶ In several of our own cases, which included fractures in the malar bone as well as those in the zygoma, we applied a modification of the Matas technic (Fig. 5), with such completely satisfactory results that we outline it briefly: the skin and adjacent soft parts to the fracture in the bone are infiltrated with a 1 per cent solution of novocain. An absence of muscle tension is desirable, and this can be obtained best by asking the patient to keep his mouth open about one-half an inch. The area immediately in front of the coronoid process (the continuation of the anterior border of the ramus) is palpated against the infratemporal surface of the maxilla until the masseteric border of the malar bone is engaged. At this point, which is directly in front of the coronoid process, a tiny superficial incision is made to accommodate the needle, or, if the area be outlined very clearly, an incision is unnecessary. A large sized Hagedorn needle, or one of similar design and function, is introduced at the site of incision, passed carefully beneath the depressed

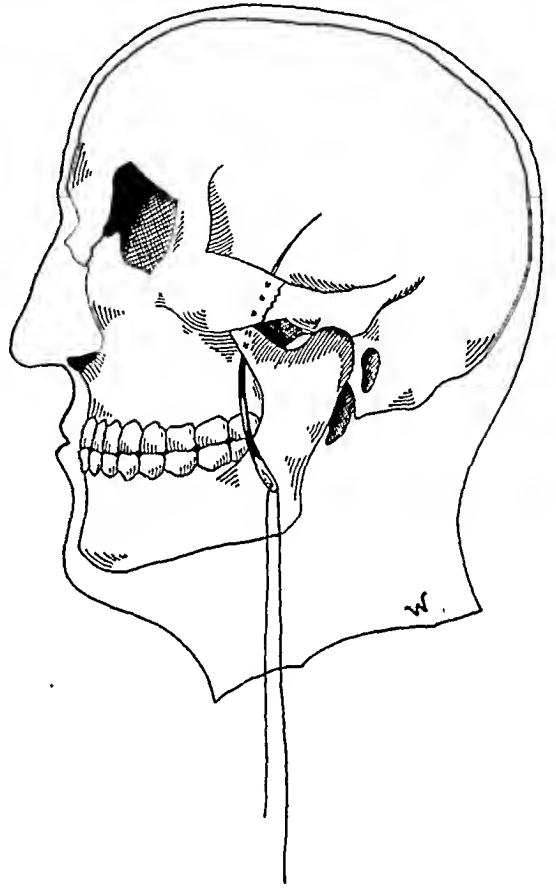


FIG. 5.—Authors' modification of the Matas method applied to depressed malar fracture.

fragment, and directed to emerge at a point just beyond the lateral portion of the temporal border of the malar bone. The needle is threaded with No. 22 gauge copper wire, and the latter passed through sterile petrolatum preparatory to entering the skin. The two ends of the wire are twisted together in one direction and traction made upward and slightly medially on the depressed fragment in order to bring it into normal position. At times the bone assumes its correct position with a sucking noise (like that of a boot withdrawn from mud), and a final click. More often, however, no sound is heard and considerable traction must be exerted before replacement is accomplished. After the reduction has been achieved, the incision is closed with a single fine suture. In these cases we have been able to dismiss the patient within 48 hours.

Recurrence of the deformity is rare and trismus, unusual. In simple fractures involving both malar bone and zygomatic arch, where the zygomatic-temporalis suture is depressed but not demarcated, it is possible to elevate both bones at one operation. Where circumstances permit, this mode of treatment will, we believe, prove simple and satisfactory, and will obviate the difficulties and objectionable features of more radical surgery.

RÉSUMÉ

In cases of this type, due to trauma, it may be assumed that the individual had been enjoying a fair degree of health. Therefore, in addition to the proper handling of the traumatic involvement, there is the twofold objective of restoring the patient to his usual vocation with all consistent speed and with the least possible impairment to his previous state of health.

Necessary considerations regarding the fracture are: (1) Regional involvement that will affect directly the reduction of the fracture. (2) Extreme precaution in preventing or minimizing infection. (3) Early reduction of the fracture. (4) Postoperative examination, at least periodically, until final discharge.

In the general handling of the patient: (1) We found local anesthesia to be especially valuable in fracture reduction, for it permitted cooperation with the surgeon during operative procedure, and eliminated the nervous dread of taking a general anesthetic as well as the systemic after effects which would tend to prolong hospitalization. (2) Attention was given to the need of an adequate fluid intake, and special diets were arranged. (3) We found physiotherapy invaluable as an aid both in the traumatized area and in connection with the general physical tone. (4) In mandibular fractures, good results were obtained by allowing the patient a temporary discharge from the hospital in order to pursue some form of light employment.

We wish to acknowledge our indebtedness and to express our appreciation to Dr. H. M. Ginsburg, Director of the General Hospital of Fresno County, Fresno, California, and to Dr. D. I. Aller, Chief of Orthopedic Surgery.

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THE NICOLA OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER *

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THE purpose of this brief paper is to describe the Nicola operation for recurrent dislocation of the shoulder joint, and to report the results of a short series of cases, which have been followed postoperatively over an average period of two and one-half years.

The number of methods which have been devised for the cure of recurrent dislocation of the shoulder joint is the best index of the difficulties of the problem that this condition has presented. The most outstanding of these may be quickly reviewed according to the structure utilized to correct the fault.

Capsule.—Riccard, Thomas, Bardenheuer and others have reinforced the capsule in various ways, usually by plication of the anterior and inferior surfaces.

Muscle and Tendon.—Fensterer and Heyman transplanted the short head of the biceps to the upper rim of the glenoid fossa suturing the tendon along the anterior capsule.

Young lengthened the pectoralis major and latissimus dorsi.

Perthes reinserted the supraspinatus.

Clairmont dissected the posterior fifth of the deltoid from its origin and carried it through the quadralateral space under the joint, fastening it to the coracoid process anteriorly.

Schosseler and Cotton shortened the subcapularis.

Bone.—Chaput and Alibut resected the humeral head.

Hildebrand deepened the glenoid fossa from behind, making the anterior lip more prominent.

Eden, Mauclore, Speed and Hybbinette placed a bone graft along the anterior margin of the glenoid fossa.

Oudard, Lenormant and Muard elongated the coracoid process to form a block against the anterior displacement of the head.

Fascia and Tendon.—Payr and Kirschner, in 1913, were the first to employ fascial transplants to reinforce the shoulder joint.

Carrell divided the long head of the biceps. The distal end was sewed to the short head. The proximal end was elongated with fascia lata and was carried under the neck of the humerus and fastened behind through a drill hole, into the acromion.

Spitzzy wove strands of silk around and through the capsule attaching them to the coracoid process.

* Read before the Joint Meeting with the Boston Surgical Society and the Philadelphia Academy of Surgery, on February 4, 1935, at Philadelphia, Pa.

Joseph and Gratz used fascia lata to make a ligament from the humeral head to the acromion.

Cattaneo used a sling of fascia lata around the capsule fastening the ends over the acromion.

Henderson transplanted the peroneus longus, threading it through the acromion and the greater trochanter of the humerus.

Wahl divided the long head of the biceps anchoring the proximal end into the greater trochanter and sewing the distal to the periosteum of the bicipital groove.

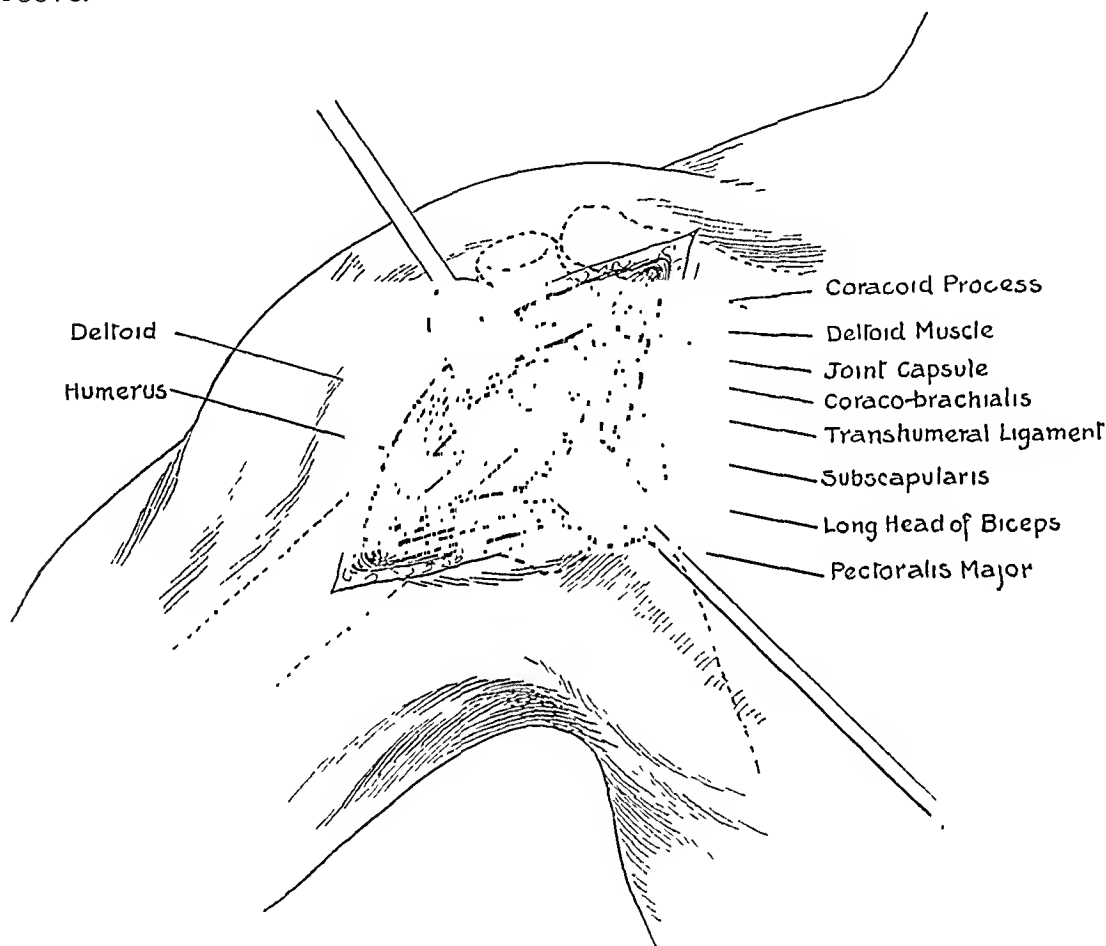


FIG. 1.—Showing approach between the deltoid and pectoral muscles.

Fowler advocated a fascial sling carried beneath the neck of the humerus and fastened anteriorly to the coracoid process posteriorly to the acromion.

Tuffic Nicola observed that the shoulder joint of most anatomic skeletons was fixed by a pin through the center of the humeral head to the glenoid fossa of the scapula. This method of fixation allowed practically normal range of motion. Recalling the similarity of the ligamentum teres of the hip joint, he conceived the ingenious idea of utilizing the long head of the biceps tendon as a check ligament to stop abnormal forward and downward motion of the humeral head on the glenoid fossa.

In 1929, he reported one case in which this method of stabilization was used. The technic of the operation consisted of the following steps:

(1) Incision from clavicle just above coracoid process four inches down along anterior margin of deltoid (Fig. 1).

(2) Division of long head of biceps one-half inch above the point where it disappears under the pectoralis major.

(3) Drilling of a hole in the bicipital groove, at level of lower edge of the transverse humeral ligament upward to emerge at the center of the head of humerus.

(4) Threading of the proximal end of the tendon through the drilled hole using a flexible probe.

(5) Resuture of the divided tendon under tension.

(6) Fixation of the arm by Velpeau bandage for three weeks.

In 1931, Nicola reported a series of 20 cases operated upon by various surgeons. The end-results were uniformly satisfactory.

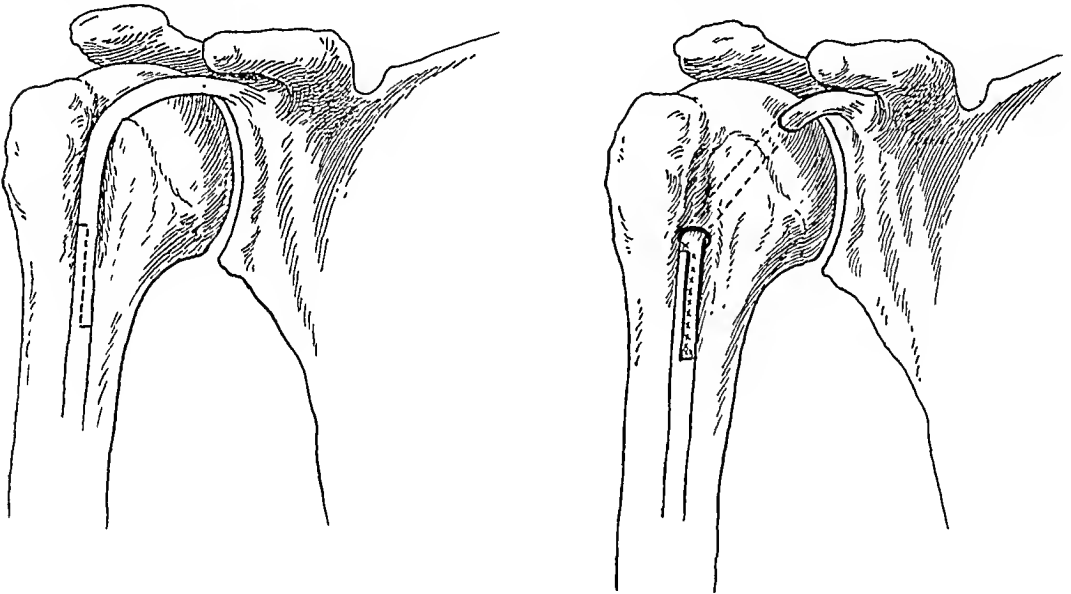


FIG. 2.—Showing division of tendon, direction of drill hole, and tendon sutured in new position.

The author had the opportunity of seeing Doctor Nicola's first case, and was impressed both by the simplicity of the technic and the functional efficiency of the result. Since then he has used this method with the following slight changes in procedure and after care.

(1) Z instead of transverse cut in tendon to give plenty of overlap for suture (Fig. 2).

(2) Placement of drill hole well anterior and above center of the articular surface of the humeral head to avoid anterior luxation and limitation of abduction.

(3) Placement of the arm in abduction with elbow flexed to right angle, while suturing the tendon to take up the slack of biceps tendon.

(4) Anchorage of the distal end of the proximal portion of the tendon to the periosteum at the point of emergence from the drill hole.

(5) Velpeau bandage for five days postoperatively and then a sling for remainder of three weeks.

(6) Passive extension and flexion of shoulder and elbow to be started at end of second week.

(7) At the end of third week, active circumduction exercises of the arm with the trunk bent forward, and with gradual increase in the arc of motion.

(8) Avoidance of elevation beyond the shoulder line for eight weeks.

In the ten cases operated upon, we have a follow up period of from one and one-quarter years to five years. The age of the cases at operation ranged from 16 to 45 years. Occupation was usually one of the more strenuous types, and, in each case, was resumed postoperatively. In the student group, there were three college men who played on varsity teams, football, basketball or crew. The one girl in the series resumed her tournament tennis. Of the laboring group there were two miners, a truckdriver, and two unemployed, who claimed they do strenuous work when the opportunity offers.

The end-results are graded according to the code accepted by the Fracture Committee. They are according to anatomic, functional, and economic results. The grade of 1 equals 25 per cent; 2 equals 50 per cent; 3 equals 75 per cent, and 4 equals 100 per cent.

There were two complications at the time of operation which bear mentioning. The first, in a case operated two days after last recurrence—a large vein presented itself in the bicipital groove. Exploration beneath failed to reveal the biceps tendon. Not without temerity this was opened to verify an hematoma of the tendon sheath. The second was a tiny thread of a tendon running from the muscle mass to the upper anterior aspect of the greater trochanter. Deeper exploration in the bicipital groove, however, disclosed the long tendon and proved this first to be a third bicipital tendon.

In the early cases slight postoperative subluxation of the shoulder joint was present, as the importance of abducting the arm and flexing the elbow was not observed. In each case, however, this slackness had been taken up by the end of three months, probably by contracture of the proximal portion of the tendon.

Case 4 had an old elbow fracture of the same arm with considerable limitation of motion. He had had the greatest number of recurrences. The dislocation could be produced by rolling over in bed. His joint showed hypertrophic bony changes. He has resumed his work in the mines, but has some aching in his shoulder after a day's work. He has been graded 3 for function.

Case 5 had a recurrence. This was a very muscular individual, a miner by occupation. Seventeen months after operation he was in a swimming race and struck a channel stake on the point of his shoulder joint at the top of his stroke. The dislocation was reduced. He has had no recurrence in the 16 months following, and has continued his work as a miner. He has, however, observed certain precautions. He was graded 1 for function.

Case 7, whose etiologic factor was epileptic convulsions, was held in a plaster Velpeau for six weeks. He has some anterior luxation of the joint when arm is abducted. He continues to have about 20 degrees limitation of abduction and external rotation. He was graded 3 for functional and 3 for

anatomic result. He cannot get a job, but the convulsions are probably a greater handicap than the shoulder (Table I).

TABLE I

Case	Age	Occupation	Side	1st Disloc.	Recur- rences	Force	Operation	Follow Up	Result A. F. E.		
1. T. W..	19	Student	L	1 yr.	4	Ab.-Ext.	1/31/30	5 yrs.	4	4	4
2. F. L...	16	Student	R	1 yr. 8 mos.	5	Ab.-Ext.	6/ 4/30	4 yrs. 6 mos.	4	4	4
3. M. S...	18	Student	L	4 yrs.	4	Ab.	12/19/31	3 yrs.	4	4	4
4. S. C...	24	Miner	R	1 yr. 6 mos.	17+	Ab.-Ext.	3/ 7/32	2 yrs. 9 mos.	4	3	4
5. W. G...	38	Miner	L	1 yr. 6 mos.	5	Ab.	3/24/32	2 yrs. 9 mos.	4	1	4
6. L. L...	28	Salesman	R	4 yrs. 6 mos.	12	Ab.	10/28/32	2 yrs. 3 mos.	4	4	4
7. A. B...	31	Laborer	L	1 yr. 20 mos.	7	Convuls.	9/ 5/32	2 yrs. 3 mos.	3	3	3
8. A. C...	45	Laborer	R	12 yrs.	12+	Ab.	6/ 6/33	1 yr. 6 mos.	4	4	4
9. G. S...	27	Truckdriver	L	4 yrs.	6	Ab.-Ext.	6/15/33	1 yr. 6 mos.	4	4	4
10. J. D...	23	Typesetter	R	2 yrs.	4	Ext.	8/24/33	1 yr. 3 mos.	4	4	4
Summary	27		5R-5L	3 yrs. 4 mos.	7+			2 yrs. 8 mos.			

SUMMARY

The operation advocated by Nicola for recurrent dislocation of the shoulder has been used by us in ten cases, with an average follow up of two years and eight months. The operative technic was the easiest of those devised for this condition. The postoperative convalescence and period of hospitalization were short. The results graded according to anatomic, functional and economic values were high. One case only had a recurrence due to an accident more than a year after operation. All cases returned to their former occupations subsequent to operation.

DISCUSSION.—DR. T. TURNER THOMAS (Philadelphia).—Few surgeons discuss operations for recurrent dislocations of the shoulder because few do them. I have done about 70 cases by the axillary route but none by these new suspension methods. In my last six cases I have tried something new which I think reduces the risk of recurrence.

I have a special interest in one of Doctor Willard's cases because I was present when he presented it before the Academy of Surgery a few years ago. It was the most detailed presentation of a case so operated on that I have heard, a good history, description of operation and the results afterward. This patient swung his affected arm around vigorously in all directions without difficulty and played football afterwards.

But Doctor Willard told us something that interested me more. He said that when the shoulder was in a severely strained position as in football, "it slid over but without a dislocation." That interested me very much because with the pathology not exposed or corrected I have been expecting to hear of some disturbance in the joint after this operation and suspected that it must occur, but Doctor Willard is the first to refer to it so far as I know.

My most serious objection to this and other operations like it is that it does not expose and consequently does not try to correct the pathology. The obvious reason is that the pathology is in the axillary portion of the joint and difficult to expose. Before these new methods came into vogue all operations aimed at restoring the joint to the normal and had a remarkable degree of success. If there were any deaths or bad results they were not reported. I cannot conceive of any of these suspension methods restoring the joint to the normal without removing the pathology although I can see how they may prevent the dislocations.

According to my conception of the mechanism and pathology of anterior dislocations of the shoulder there develops around the protruding head an axillary hernial pouch of capsule and synovial membrane which in recurrent dislocations is ever ready to receive the humeral head whenever the hyper-abducting force is strong enough to pry it out of the socket. The long head of the biceps in its transplanted position cannot hold it in the socket in this position of abduction which relaxes it. But after the head has "slid over" the glenoid margin into the dislocated position, the arm in dropping to the side of the body from gravity can tighten the biceps tendon, which can then pull the head back into the socket. It could provide a spontaneous reduction as probably often happens in unrecognized dislocations of the shoulder.

The success of this operation depends entirely upon the integrity of the transplanted tendon. How long it can withstand the wearing friction of its artificial bony canal has not been determined. The overwhelming majority of my cases have had for varying periods, some for 25 years, down to the last reports more or less recently, complete absence of the recurrent dislocations and apparently normal joints. There is nothing in the literature, evidently, to indicate that other surgeons by the older methods, except excisions, have not obtained as good results. More detailed reports will be necessary to establish as good results for the newer methods.

DR. DEFOREST WILLARD.—Doctor Thomas in his discussion brings out the fact that the Nicola operation does not correct the relaxation of the shoulder capsule. It does, however, prevent the humeral head from exerting force against the weakened capsule, providing that the insertion of the biceps tendon in the humeral head is correctly placed. I believe that prolonged fixation of the head by this new tendon allows the weakened capsule to thicken and strengthen. Although we had a little sliding, in our earlier cases, this has now ceased, and our one recurrence was due to a major accident, which would probably have dislocated any normal shoulder.

VOLKMANN'S ISCHEMIC CONTRACTURE IN HEMOPHILIA

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IN 1822, Volkmann¹ described a contracture of the muscles of the leg in a 16 year old boy which followed the application of a splint and a compression bandage in the course of treatment of hydrops of the knee joint. This description is the first record of the recognition of a comparatively clear cut clinical picture now generally known as Volkmann's ischemic contracture. A particular interest in the etiology of this condition was stimulated by the studies of Bardenheuer,² in 1911, and J. B. Murphy,³ in 1914. Whereas Volkmann¹ and Leser⁴ had emphasized anemia from arterial obstruction as the principal causative factor, Bardenheuer and Murphy believed that obstruction of the veins was the important etiologic agent. From experiments on animals, Brooks,⁵ in 1922, and Middleton,⁶ in 1930, showed that an acute myositis and subsequent fibrosis and contracture of a single muscle could be produced by venous obstruction. These experiments would seem to substantiate beyond reasonable doubt that the characteristic clinical picture and pathologic changes of Volkmann's contracture could be reproduced in animals by venous obstruction. The fact remains, however, that numerous clinical observations, for example, those of Tinel,⁷ and experimental evidence from the studies on arterial obstruction, for example, Brooks and Johnson,⁸ make it impossible to avoid the conclusion that fibrosis and contracture of muscles may also be produced by arterial obstruction. A clear cut differentiation of the contractures following arterial obstruction from those following venous obstruction has not as yet been made.

The relationship between the application of a constricting dressing and the subsequent development of Volkmann's contracture has frequently been of more than academic interest to surgeons. Murphy³ states: "The lesion in Volkmann's contracture is a surgeon's lesion and never a lesion due to the trauma. It is a lesion due to a defective dressing." It is interesting to note, however, that two years after the publication of this statement, Murphy³ reported an instance in which Volkmann's contracture had occurred without a previous constricting bandage. He states: "Certain it is that a severe contusion of the muscles of an extremity without fracture or external wound or evidence of injury may be followed by this contracture." Other instances of Volkmann's contracture without the previous application of a constricting bandage or of a fracture have been recorded. The purpose of this paper is to

report an instance of the development of Volkmann's ischemic contracture in a hemophiliac in whom no bandage or splint had been used and in whom there was no preceding trauma. Five such cases have been previously reported.

CASE REPORT

A 22 year old white male was admitted to the Vanderbilt University Hospital February 19, 1927, complaining of pain and swelling of the knee and elbow. The patient's past history was characteristic of hemophilia. On numerous occasions he had bled profusely from a small wound. There had been frequent attacks of spontaneous ecchymoses in the skin, sudden development of pain and swelling in joints and bleeding from the gums. The patient had two living brothers who were similarly affected. A third brother died at the age of eight from a profuse hemorrhage from a slight blow on the nose. The patient refused to remain in the hospital for a sufficient length of time for complete examination. Blood examination, however, showed normal platelet count and approximately normal clotting time.

The patient was readmitted to the Vanderbilt University Hospital July 8, 1927, because of persistent bleeding from the gums. He again refused to remain for a complete examination. The previous pain and swelling of the joints had for the most part disappeared.

November 15, 1932, he was admitted to the Vanderbilt University Hospital for the third time because of contracture of the left hand. Four months previous to this admission, the patient stated he had gone to bed feeling quite well, but was awakened during the night with a feeling of numbness in the left hand and forearm. Within an hour the hand and forearm were observed to be quite cold and extremely painful. The pain was of such severity that a physician was called and morphine administered. The following day the pain continued to be severe, and the hand and forearm were observed to be hot. Large doses of morphine were necessary for the relief of the pain. The patient was instructed to bathe the hand with hot water. Discoloration and ulceration of the skin of the fingers developed. The terminal phalanx of the index finger became gangrenous and was amputated. A marked flexion contracture of the fingers developed.

On examination, the left hand and forearm showed the characteristic appearance of Volkmann's ischemic contracture (Fig. 1). The fingers and thumb were fixed in extreme flexion. The muscles of the forearm were firm. There was complete anesthesia of the entire hand and impairment of sensation in the distal third of the forearm. The distribution of the anesthesia was of the characteristic "glove" type. Pulsations in the radial artery were approximately normal.

The patient was observed for a period of one and one-half months, during which



FIG 1—Photograph of left hand, November, 1932, four months after onset of contracture. The necrosis and ulceration of fingers probably due to hot applications in the presence of anesthesia.

time the clotting time varied from 6 minutes to 22 hours. Platelet count, 290,000. The blood clot retracted. Blood calcium, 14.89 mg.

Roentgenogram of the hand and forearm showed exostoses of the bones of the forearm and marked atrophy of the bones of the hand and wrist (Fig. 2).

A small incision was made over the flexor muscle of the left forearm under local anesthetic. The muscle appeared pale and there was obviously extensive replacement of muscle fibers by fibrous tissue. A small piece of muscle was excised for examination. Microscopic examination of the specimen showed the characteristic pathologic



FIG. 2.—Roentgenogram of both forearms showing synostosis between left radius and ulna.

changes of Volkmann's ischemic myositis. In some areas the muscle fibers had been completely replaced by dense fibrous tissue. In other areas the remaining muscle fibers were greatly distorted in size and shape (Figs. 3 and 4).

Because of the anesthesia and ulceration of the fingers, it was deemed inadvisable to institute any measures for the correction of the deformity. May 21, 1935, the patient returned for examination. He had almost entirely recovered sensation in the hand. There was normal pulsation in the radial artery. The ulceration of the hand had completely healed. The contracture was unchanged (Fig. 5).

Appended is a brief summary of the reports of the previously recorded cases of Volkmann's ischemic contracture developing in hemophiliacs.

Summary of the Case Reports in the Literature of Five Instances of Volkmann's Ischemic Contracture Developing in Hemophiliacs

CASE I. J. P. Lord:²¹ A boy 16 years old, who had hemophilia, developed spontaneous hemorrhages below both elbows, followed by the typical Volkmann's contractures. No biopsy.

CASE II.—Evandro Pasquali:²³ Male, aged eight, with hemophilia. A past history of hemorrhage following trauma. Patient fell and struck his right elbow against the ground, followed in 24 hours by pain in the hand and arm, with a gradual flexion contracture of the hand. No evidence of fracture.



FIG. 3.—Photomicrograph of excised piece of muscle showing complete replacement of muscle fibers by fibrous tissue.



FIG. 4.—Photomicrograph of excised muscle showing an area in which a few abnormal muscle fibers remain in fibrous tissue.

CASE III.—M. Frelich:²² Boy, four years old, suffering from hemophilia, injured his arm April 11, 1925, followed by marked swelling, and the arm was placed in a sling. In two weeks the swelling disappeared and a typical flexion contracture had begun. No roentgenographic evidence of fracture.

CASE IV.—E. W. Hey Groves:²³ Seven year old male hemophiliac who was pulled by his left arm, in an attempt to extricate him from a crowd. This was followed by bruising, swelling and stiffness of the elbow and wrist, which gradually disappeared, resulting in a wasted, contracted limb.

CASE V.—E. W. Hey Groves:²³ Eleven year old male with hemophilia fell and struck left elbow against the ground. A few days later he noticed the fingers became clawed. A splint was applied for four weeks. After its removal the fingers were found to be in a state of marked contracture.

In a review of the available literature there were found 123 instances in

which Volkmann's ischemic contracture developed without the previous application of any constricting dressing. In 90 of these cases the contracture followed an injury in which a fracture was sustained. The frequent development of ischemic contracture after supracondylar fractures of the humerus in which no constricting dressing is used, 20 per cent according to Steindler,⁹ is evidence that this condition is not always the result of defective dressings. Bardenheuer² estimates an incidence of 8 per cent of Volkmann's ischemic contracture occurring without previous application of constricting dressings.

In 28 cases a contracture followed an injury in which no fracture had

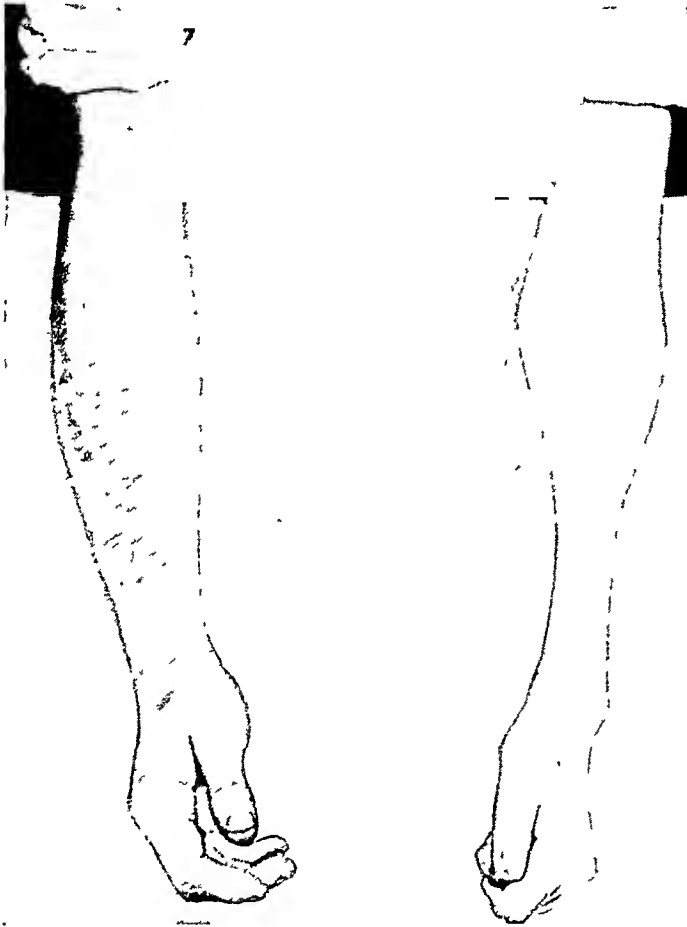


FIG. 5.—Photograph of both hands and forearms showing extent of the contracture in the left hand, approximately three years after onset.

occurred nor was any constricting bandage applied. The reports of these cases¹¹⁻²⁰ are not sufficiently complete to determine in each case the exact severity of the trauma, but one gets the impression that it was moderately severe in each instance. There was no evidence that any of these patients was suffering from an abnormality of the blood. In the six instances of Volkmann's ischemic contracture occurring in hemophiliacs, no constricting bandage had been applied, and relatively little or no trauma had been sustained.

The pathogenesis of spontaneous Volkmann's ischemic contracture in

hemophilia is probably well summarized in J. B. Murphy's statement in discussing an instance in which this condition developed in a patient who sustained an injury of the elbow without a fracture or a constricting dressing. He states: "In our case it is fairly clear that hemorrhage beneath the aponeurosis may cause myositis and subsequent contracture, even when splints or bandages have not been used." Pasquali¹⁰ perhaps summarizes the pathogenicity of spontaneous Volkmann's contracture in hemophiliacs even better when he says in substance: "In hemophiliacs it is comparatively easy for a deep extravasation of blood to occur in the region of the elbow where the particular anatomic disposition of the veins makes the conditions favorable for the development of an ischemia of the nature to produce myositis." In other words, it is not the extravasation of blood into the muscles, but the pressure conditions which result from the extravasations of blood into a space containing muscles, surrounded by comparatively rigid fascia and drained of blood by a peculiar anatomic arrangement of the veins which favors obstruction. It is not improbable that the myositis and subsequent contracture could be averted by a subcutaneous division of the fascia through a small skin incision.

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BRIEF COMMUNICATIONS AND CASE REPORTS

RADICAL EXCISION OF TUBERCULOUS CERVICAL LYMPH NODES AND LOCAL EXCISION OF CARCINOMA OF PAROTID GLAND*

SIX YEAR FOLLOW UP

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CASE REPORT

A. L. (84675), 36 years of age, was admitted to Vanderbilt Clinic, June 13, 1929. At the age of eight he had mumps. At ten he was ill with a pain in his chest, aggravated by breathing, fever, cough, and, at times, hemoptysis. His chest was not tapped, his sputum never examined for tubercle bacilli, and his lungs were not roentgenologically examined. Similar symptoms recurred when he was 17 years old, except that he did not cough blood. At the age of 18, following an accident to the left side of his neck, there appeared a small lump in the middle of the neck just in front of the left sternomastoid muscle. At the end of a year it had increased markedly in size, and it was excised in Lund Hospital in Sweden. Six months following this operation, the swelling reappeared and he was treated by roentgen therapy once every two weeks, for three years, receiving approximately 50 treatments.

Three years later the mass opened and discharged. The sinus was curetted and remained healed for four years. Then, two years after the patient came to America, the swelling reappeared. In 1925, a tonsillectomy was performed at Harper Hospital in Detroit. This did not influence the size of the mass and six months later he was treated, three times a week for five months, with local and general ultraviolet light. During these treatments, the mass reopened and discharged.

When he presented himself at Vanderbilt Clinic he was well developed and well nourished, weighing 148 pounds; temperature, 98.6° F.; urine, negative; red cells, 5,150,000; hemoglobin, 95 per cent; white cell count, 4,800, with 59 per cent polymorphonuclears, 33 per cent small lymphocytes, 3 per cent large lymphocytes, 4 per cent transitionals, and 1 per cent eosinophils. Wassermann, negative. On the left side of the neck was a healed scar, 1 cm. long, 3 cm. below the tip of the mastoid process, to which there was adherent a firm mass approximately 3 cm. in diameter. July 16, 1929, under local anesthesia, this mass was excised.

Pathologic Examination.—The specimen proved to be a mass of cervical lymph nodes 3.5 by 1.5 by 1.5 cm. Microscopic examination revealed active tuberculosis with giant cells and caseation necrosis. There were irregular masses of round epithelial cells with oval pale staining nuclei with mitoses in each second high power field. In another area, the epithelial cells showed an orderly arrangement into glands: *Diagnosis.*—Tuberculosis of cervical lymph nodes, carcinoma metastases to cervical lymph nodes following carcinoma of unknown origin (Figs. 1 and 2).

A search for a carcinoma focus revealed no evidence of malignancy in the nasopharynx, larynx, esophagus or bronchi. August 6, 1929, under colonic ether anesthesia, a radical upper and lower cervical and supraclavicular dissection was done, after the technic of Semken. The operation was followed by a 500 cc. whole blood transfusion.

* Presented before the New York Surgical Society, May 8, 1935.

The pathologic report of the tissue removed showed no tuberculosis or carcinoma in the nodes, but active tuberculosis in the skin and subcutaneous tissue about the previous operative site. June 28, 1934, five years later, the left pre-auricular node became enlarged, and was excised. Microscopically, it showed active tuberculosis.

At the present time—70 months after operation—he is symptomless and without noticeable disability.

Comment.—This case is shown as one of recurrent tuberculosis of the upper superficial cervical lymph nodes which, when excised along with a part of the lower pole of the parotid to which the mass was adherent, showed microscopically a relatively low grade carcinoma in the lower pole of the parotid gland included in the excised specimen. Because of the patient's youth, the presence of carcinoma and tuberculosis in the cervical region, a radical dissection of the upper and lower neck and supraclavicular regions



FIG. 1.—Photomicrograph showing carcinoma of the lower pole of the parotid gland.

FIG. 2.—Photomicrograph showing tuberculosis of the cervical lymph nodes.

was done, including the excision of the sternomastoid muscle and the spinal accessory nerve in an effort to rid him of both diseases, and, except for a recurrence of tuberculosis in the left pre-auricular node which was excised one year ago, the patient has remained clinically free of evidence of persistence of carcinoma and tuberculosis of the parotid gland and left cervical region for six years.

Rokitansky stated, many years ago, that carcinoma and tuberculosis are antagonistic and rarely occur in the same individual. Since then, however, both have been seen in the same patient many times, particularly in the skin, breasts, stomach, rectum, uterus, cervix, ovary and lungs.

Centanni reported that when tubercle bacilli and tumor tissue were injected in animals, neither grew. Cherry, however, reported the acceleration of spontaneous tumors by the injection of tubercle bacilli. The experimental work is inconclusive.

Pearl, in 1929, from autopsy material at Johns Hopkins, concluded that "a definite and marked incompatibility or antagonism does exist."

Thibaudeau reports from the State Institute for the Study of Malignant Disease, Buffalo, N. Y., that in five years, out of 66,711 specimens examined,

10,897 were carcinoma, and of these 21 had active tuberculosis either in the same area or in regional nodes, as follows:

- 9 Skin—tuberculosis and carcinoma.
- 9 Breasts—6 carcinoma and tuberculosis, 3 tuberculosis in the axillary nodes with carcinoma in breast.
- 1 Cervix—epithelioma with tuberculosis.
- 1 Uterus (fundus)—malignant leiomyoma with tuberculous endometritis.
- 1 Stomach—carcinoma metastasis to lung with tuberculosis there.

Of 1,661 breast carcinomata, nine had tuberculosis there also, and in 41 tuberculous breasts there was no carcinoma in the five year period. Of 371 dead of malignancy, 22 showed active tuberculosis at autopsy, or 5.9 per cent with active tuberculosis dying of carcinoma. Two cases of Hodgkins' disease were included as malignant disease. Eleven were squamous cell epithelioma from the mucous membranes. In 15,000 cases of tumors examined for treatment only 22 showed active tuberculosis and cancer. He concludes that associated tuberculosis and carcinoma is uncommon. Apparently there is no antagonism. However, a chronic irritation of a tuberculous lesion may predispose to carcinoma.

DISCUSSION.—DR. GEORGE H. SEMKEN (New York) thought that Doctor Smith's case was unique and that it was surprising not to have had recurrence of cancer follow this limited excision of the parotid gland. Cancer of the parotid is rare. The predominant type of tumor in the parotid is the composite or mixed tumor, which frequently follows the pattern of the fibro-epithelial "cylindroma" (Billroth). These tumors recur when incompletely removed; and some end as malignant new growths with metastases, chiefly in the lungs and bones. Cancer in the region of the parotid may be a primary tumor in the salivary gland, or it may be a metastatic process in the lymph nodes incorporated in the parotid gland.

The radical operation for cancer of the parotid—the removal of the parotid and related cervical lymphatics—is considered one of the most difficult and dangerous in surgery. The deep portion of the parotid extends well into the depth in close proximity to the internal carotid artery, the internal jugular vein, and the vagus nerve; but it is separated from these by a thin fascia which extends upward from the posterior belly of the digastricus. If the dissection is done from below upward and forward, the external carotid artery and the internal jugular vein can be secured early; and, if the fascia from the digastricus is followed as a guide, there will be little likelihood of injury to the great vessels and the accompanying nerves. The branching vessels and the accessory portion of the gland offer no technical difficulties. The facial nerve is necessarily divided; but the resultant paralysis can be overcome in part by a muscle or fascial transplant, or, in suitable cases, by transplanting the lower division or the hypoglossal nerve.

In Doctor Smith's case the interesting question of the significance of the association of cancer and tuberculosis in the same region in one patient was again brought up. This was recently discussed at a meeting of the American Association for Cancer Research; and it was generally agreed that there was no definite relationship between these two conditions, either in a possible predisposition produced by tuberculosis or in an antagonism. In Doctor Semken's experience, many patients with intra-oral cancer, in whom there

had been no cancer metastases in the regional lymph nodes, also had tuberculosis in some of these nodes. This is not surprising when it is remembered that from 25 per cent to 40 per cent of all people (in autopsy records) show evidences of having had some form of tuberculosis; and some of these must certainly come within the group having cancer. One reason why this association is not more frequently noted may lie in the fact that cancer is essentially a disease of older people, while tuberculosis is predominantly a disease of the young. It is probable that this association of cancer and tuberculosis may be dismissed as relatively without significance.

The third question that came up in Doctor Smith's case was that of the treatment of tuberculous lymph nodes. Doctor Semken thought it unwise to emphasize the treatment of such nodes with roentgen rays. This treatment, although seeming to have some influence in healing sinuses from broken down tuberculous nodes, in general has a limited value. There is still a lack of uniformity among radiologists as to the optimal dosage, it being the practice in this country to give frequently repeated small to minimal doses, whereas, abroad, many advise large doses, singly or repeated.

In this disease, the infection is with the human type of tubercle bacillus. The lymph nodes involved are usually those of the carotid packet, regional to the nasopharynx and fauces; and it is generally agreed that the portal of entry has been the tonsils (or possibly nasopharyngeal adenoids). When cervical lymph nodes of other groups seem alone to be affected, it is probable that the invading bacilli passed through the resistant, immediately regional groups, to find lodgement in susceptible nodes farther along the chain. The tubercle bacillus seems to have the power of penetrating the unbroken mucous membrane of the tonsil without leaving any evidence of this invasion; or the small primary ulcers have healed; or there may be a small ulcer in the base of one of the crypts, either not visible or visible only at one edge. It is the usual experience with patients who have tuberculous cervical lymph nodes that no evidence of tuberculosis is found in the tonsils, despite the regional association. Nevertheless, in Doctor Semken's opinion, the treatment of these cases should invariably begin with removal of the tonsils, before any attempt is made to remove the diseased lymph nodes. The failure of early retrogression in the lymph nodes following an adequate tonsillectomy need not be a discouragement, nor does it disprove the casual relationship of the tonsils to the diseased nodes. In one personal experience of this sort, an enforced delay became necessary, in the proposed node dissection following an apparently ineffective tonsillectomy done four weeks earlier. In the ensuing weeks a complete retrogression took place in the relatively large packet of tuberculous lymph nodes, and there has been no reappearance of the disease. The removal of the tonsils and nasopharyngeal adenoids also closes the door to possible later invasions via these portals. The extirpation of the lymph nodes follows the anatomic grouping of these nodes. It may suffice to limit this to the immediately regional group invaded; but the unnoted extensions of the infection often make more comprehensive dissections necessary.

DR. JOHN M. HANFORD (New York) reported the case of an elderly woman in poor condition upon whom he first operated for cancer of the parotid in 1920. The lesion was arrested for some time, but finally reappeared, and in 1930 she was again operated upon, after radium had been applied. The swelling subsided and did not reappear until a few months ago when it occurred in the anterior part of the parotid and reached a size of 3 or 3.5 cm. in diameter. It was very hard, and definitely malignant. Thus for

15 years, on and off, this patient has had—and still has—carcinoma of the parotid gland. There has been no doubt about the diagnosis. She is fairly well and has never had metastases to the lymph nodes. For many years, however, it was considered that she had very definite and quite extensive metastases to the lung. But she continued well, except for the occasional local recurrences. The round shadows in the lungs that we thought typical of malignant metastases remained stationary. On her last visit to the hospital the roentgen ray department concluded that the findings in the lungs were not metastases but a very peculiar and unusual type of tuberculous masses. In any event the lung findings have been present for seven or eight years, without change.

With regard to tuberculous nodes, Doctor Hanford strongly disagreed with the practice of taking out the tonsils first. He thought that they were rarely the primary seat of infection and pointed out that tubercle bacilli may go through the tonsils without causing a primary lesion and that it is very rare in most people with tuberculous cervical lymph nodes to have tuberculosis of the tonsils. Even when they do, the disease in the lymph nodes is already established; the process is under way; and removal of the tonsils is not more likely to cause an arrest of the tuberculous process in the neck than is removal of one of the lymph nodes. In his opinion it is much better to treat the lymph nodes first, especially if one plans to remove them. Liquefaction may go on in a very short time. Tonsillectomy predisposes to liquefaction. Hence, it is much better to operate on the nodes before this occurs.

DR. JOHN E. JENNINGS (Brooklyn) expressed his general support of Doctor Semken's attitude and mentioned the decrease in recent years of tuberculous nodes of the neck. Some 20 or 30 years ago there were regularly five to ten or more cases in the wards, whereas he had not seen a case of this kind in recent years. He said that this is accredited to the removal of the tonsils, and by public health men as the result of better milk. Whatever the cause, in his experience tuberculous nodes in older children and young adolescents had almost disappeared.

DR. F. W. BANCROFT (New York) stated that at Fifth Avenue Hospital, which is at present a drawing area for Porto Ricans and Central Americans, there are a good many cases of tuberculous cervical adenitis, there being two or three there at the present time, as well as one woman with a large tuberculous adenitis of the retroperitoneal lymph nodes.

DR. CHARLES E. FARR (New York) cited two cases in which he had performed a radical operation for carcinoma of the parotid. In both cases, he was able to preserve the facial nerve. In one patient, a comparatively young woman, the condition was recurrent when he first saw it. The operation plus roentgen therapy has kept her alive and well four or five years. The other patient, an older man with a more extensive carcinoma, stayed well for two years after a radical operation, then disappeared. He doubted that either was a permanent cure.

DR. HERBERT WILLY MEYER reported a case of adenocarcinoma of the parotid operated upon by him at the Lenox Hill Hospital. The patient had a small lesion near the lower pole of the parotid, considered a mixed tumor. Excision was done and it proved to be a very active carcinoma. Three days after the primary operation a complete radical operation was done, the entire parotid gland being removed, together with a block dissection of the

cervical lymph nodes. Metastases in the lymph nodes of the lower chain were found. The patient had, of course, paralysis of the facial nerve. Plastic repair of the eye and angle of the mouth with two strips of fascia lata was done to overcome the paralysis. The patient is now over 70 years of age, is happy in spite of the facial paralysis, does not look very much deformed, and has been well for six years.

DR. FRANK E. ADAIR pointed out the great diagnostic help furnished by the use of a sialogram injection. After drawing out a little fluid, the duct is injected and roentgenograms made which reveal a good deal about the pathology of the parotid gland: particularly whether there is a stone obstructing it, whether there is an inflammatory condition of the gland, or whether there is a carcinoma. He thought that the cure in the case under discussion might be partially attributable to the pathology. Ordinarily, carcinoma of the parotid cannot be cured by such a simple surgical extirpation as that carried out by Doctor Smith. From a study of Fig. 1, the lesion does not seem to be a very active type of carcinoma, in that it is not infiltrating and not completely circumscribed. Even though it has mytotic figures, some pathologists would not call it carcinoma without infiltration.

DOCTOR SMITH explained that the tissue removed at the radical operation showed no carcinoma in the portion of the parotid then removed; at the second operation, there was none in the cervical lymph nodes but the nodes showed tuberculosis. Dr. A. P. Stout diagnosed the lesion as a small, low grade carcinoma, there being infiltration in the gland itself and in the capsule, apparent in parts of other sections.

CONGENITAL ATRESIA OF DUODENUM IN NEWBORN*

DUODENOJEJUNOSTOMY

EDWARD J. DONOVAN, M.D.

NEW YORK

CASE I.—Baby F., a cesarean delivery, was transferred from Sloane Hospital to Babies Hospital, with a history of having vomited bile stained material since birth. The mother had one other living child and one labor was terminated by craniotomy.

The patient weighed seven and one-half pounds at birth, but lost about one-third of this in the next eight days. She vomited continuously following birth, and her stools, said to have been passed daily, consisted largely of meconium. Becoming dehydrated, she was kept alive by clyses, etc. Roentgenograms on the ninth day of age disclosed obstruction in the third part of the duodenum.

The abdomen was opened through a right subcostal incision. The first and second portions of the duodenum were almost as large as the stomach. This dilatation seemed to extend downward to the point where the superior mesenteric vessels passed over the duodenum. The jejunum beyond the duodenojejunal junction was completely collapsed. There was no other demonstrable cause for the obstruction. The jejunum about 10 cm. beyond the junction was brought anterior to the colon and anastomosed to the lower part of the dilated duodenum by three rows of sutures. Continuous intravenous drip of glucose in saline was started and continued for 60 hours. Convalescence was uneventful except for some postoperative vomiting for the first five days. After the fifth day, there was no vomiting and the child made rapid progress.

* Presented before the New York Surgical Society, May 8, 1935.

It is now seven months since operation. The child does not vomit and is gaining weight normally, now weighing 16½ pounds. A roentgenogram shows a normal duodenal cap and that the duodenum is almost completely empty within 20 minutes.

CASE II.—C. B., a male child, was admitted to Babies Hospital at the age of 17 days, with a history of having vomited everything since birth. He was an instrumental delivery. He was taken off his mother's milk and put on SMA, but still vomited after every feeding, and in this period lost almost two pounds. The vomiting was not projectile, but was always bile stained. The history was that the stools had always been of normal color.

Physical examination revealed a large child showing considerable loss of weight. Otherwise it was negative except for the upper abdomen, which was distended, with visible peristaltic waves passing from left to right. Roentgen examination showed a duodenum that was very large in its first and second portions. Small amounts of barium passed through the dilated duodenum at 40 minutes.

OPERATION.—The abdomen was opened through a right subcostal incision and the stomach, except for some dilatation, was found to be normal. The first three parts of the duodenum were as large and thick walled as the stomach. The jejunum beyond the duodenojejunal junction was about half normal size. The obstruction was at the point where the superior mesenteric vessels passed across the duodenum. An anterior duodenojejunosomy was done by suture, a point on the jejunum where it could be approximated without tension being selected for anastomosis. Three rows of sutures were used, leaving a stoma about one inch long, running transversely. Following operation fluids were administered intravenously.

The child vomited bile stained fluid several times during the first five postoperative days. The stomach was emptied by a Levine tube. From the fifth day on convalescence was uneventful except for a subacute otitis. On February 16, 20 days postoperative, he was discharged.

Three months have elapsed since operation. The child now weighs 16½ pounds and does not vomit. His incision has healed soundly. Roentgenograms during the past week show a normal passage of barium through the stoma in 20 minutes.

DISCUSSION.—DR. CHARLES E. FARR (New York) called attention to the remarkable fact that most surgery in the abdomen in infants is in the right upper quadrant. Referring in particular to the two cases upon whom a duodenojejunosomy was done, he regarded the incision used by Doctor Donovan as a very useful one for the exposure needed. In only occasional cases is any other incision necessary, and in these one is quite aware of that necessity before operating. Although Doctor Farr had not had a case of complete atresia of the duodenum necessitating a duodenojejunosomy, he had had quite a number of cases of fairly complete atresia or stenosis requiring surgery, occurring months or years after birth. The etiologic factor was usually found to be due to bands, kinks, or misplacements of viscera, not requiring a duodenojejunosomy. He felt that Doctor Donovan was especially to be congratulated on his marvelous skill in handling very little infants with their extremely delicate tissues. The greatest operative difficulty, he emphasized, is not with the dilated portion of the duodenum, but with that part which has never functioned, or, if it has, only very slightly. Even when successful in making a competent anastomosis one cannot be sure that the portion that has never functioned is going to take up its work and carry on, as exemplified in Doctor Farr's experience, by disastrous results in the lower bowel where, at postmortem, it was apparent that technically the work was good but obviously function had not occurred. Doctor Stockard's suggestion is to start at once with enemata and give them rather fre-

quently so that the bowel may be forcefully drained from below and peristalsis stimulated.

DOCTOR DONOVAN stated that he had performed an antecolic duodeno-jejunosomy rather than a retrocolic duodenojejunosomy in these cases because the transverse mesocolon in a baby so young is very short and very thin. By doing an antecolic operation, the danger of interfering with the middle colic artery is lessened. The technic is the same as that of an anterior gastro-enterostomy, the jejunum being anastomosed to the dilated duodenum with three rows of sutures and the stoma running transversely. The only objection to the method is the possibility of a little difficulty in making the stoma low enough on the dilated duodenum to drain it properly, but in all of Doctor Donovan's cases this has worked well. An entero-enterostomy was not necessary in any of the five cases in his experience.

PSEUDOMYXOMA PERITONEI*

PROBABLY OF APPENDICEAL ORIGIN

FRANK L. MELENEY, M.D.

NEW YORK

IN FEBRUARY, 1933, this patient was first presented to the New York Surgical Society.¹ He was a man of 45 years with a tender mass in the lower abdomen extending somewhat more to the left than to the right of the midline. It proved to be a mass of infected tumor tissue containing quantities of mucus and a disorderly but well differentiated growth of mucous membrane. The consensus of opinion was that it had probably arisen from an appendix which had extended across the midline to the left

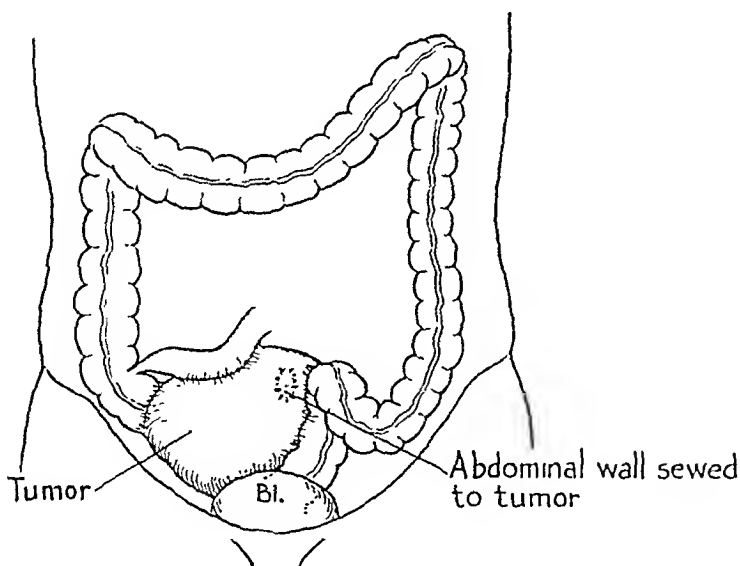


FIG. 1.—First operation. Showing what was inferred to be its general anatomic relations.

side and had probably ruptured and transplanted some of its mucous membrane in the peritoneal cavity (Fig. 1). It seemed to have subsequently invaded the lower ileum and the sigmoid for fecal fistulae had been established at all three of these sites. By a series of operations, including an amputation of the cecum, an ileo-colostomy with a tape ligature of the ileum below the tumor, and a permanent left inguinal descending colostomy,

* Presented before the New York Surgical Society, April 24, 1935.

¹ ANNALS OF SURGERY, vol. 98, pp. 458-460, 1933.

the tumor was shut off from the fecal stream (Figs. 2 and 3), but it was still present in the abdomen, the mucous membrane was producing large quantities of mucus and the tumor seemed to be invading the abdominal wall. At that juncture, the case was presented with the hope of obtaining some advice concerning further procedure to eradicate the disease. No suggestions were offered.

In March, 1933, the tumor continuing to pour out purulent mucus, an attempt was made to remove it from within the cavity of the tumor, but in doing so the peritoneum was opened. The stump of the ileum and the stump of the sigmoid were brought up into the wound and the skin sutured to the outer wall of the tumor as far posteriorly as possible (Fig. 4), about one-third of the tumor was removed. The pathologist (Dr. A. P. Stout) then diagnosed it colloid carcinoma. No peritoneal infection developed and two weeks later another attempt was made to remove the tumor from within its own cavity. The mucous membrane was shelled out from the wall of the cecum and from the ileum down to the tape ligature near the ileocecal valve. Likewise the mucous membrane was shelled out of the sigmoid as low down as possible and cut across. The lower cuff was then inverted and the muscular wall of the sigmoid approximated over the inverted mucosa. The tumor was then gently curetted off the posterior abdominal wall. Below the mesentery of the ileum it seemed to have invaded the deeper tissues. Again the pathologist made a diagnosis of colloid carcinoma. In view of this fact we decided to apply radium to the remaining cavity. Dr. Maurice Lenz gave a maximal dose ten days after the excision, 150 mg. being applied for a total of 3,450 mgh. The cavity then began to contract down. One month later, the tape previously used to tie off the ileum sloughed out. The cavity then contracted to about 1 cm. in diameter and 3 cm. deep, and continued in this relatively innocuous state for eight months. Then there appeared, in the lower wall, a granular area which began to secrete mucus. The cavity began to grow larger. An attempt was made to excise the whole area of the cavity. In doing so the peritoneum was entered but again healed without infection. The specimen again revealed disorderly epithelial tissue which was called carcinoma.

With the patient completely aware of the situation we proposed an attempt at radical removal. March 10, 1934, the peritoneum was frankly entered and dissection carried out from above downward. We were surprised to find how cleanly it could be removed from the posterior wall of the abdomen and pelvis. The rectum was cut across low down and the stump inverted (Fig. 5). A large area of anterior abdominal wall was removed. The closure was difficult. The bladder was brought up to close the defect in the peritoneum. This was covered by a large piece of fascia lata. The patient was kept bent forward by means of the Gatch bed and the wound healed with surprising firmness. The patient left the hospital on the twenty-third day and gained steadily in strength. The large piece of excised tissue was carefully searched for tumor but no trace could be found. He returned to work a month later and has steadily improved. The colostomy functions satisfactorily although there is a weakness of the abdominal wall around it. He has gained 100 pounds in the last year and apparently has recovered completely.

DR. A. P. STOUT (New York) explained that, in regard to the origin of the epithelium, it had never been possible to determine where it came from, but that the most probable source in pseudomyxoma of the peritoneum in the male is the appendix. It was hoped during the course of the various operations that the appendix would be seen so that it might be determined whether it came from that, but it never was. Another possibility was that it might have come from an enterocystoma, although that is a much rarer lesion. These cases are really extraordinary because the epithelium of the mucous membrane of the gut behaves as if it were malignant tissue, growing out over the surface very persistently, and yet it usually does not infiltrate or become cancerous. There was a time during the course of these operations

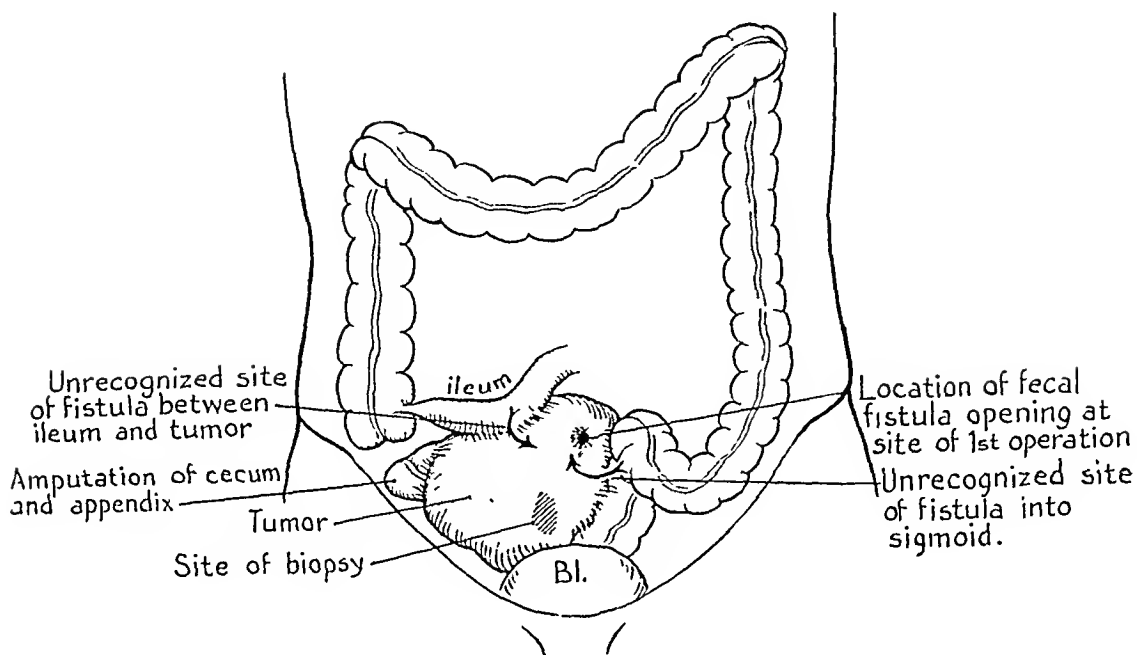


FIG. 2.—Fourth operation. An effort made to cut off the fecal flow from the tumor by amputation of the cecum.

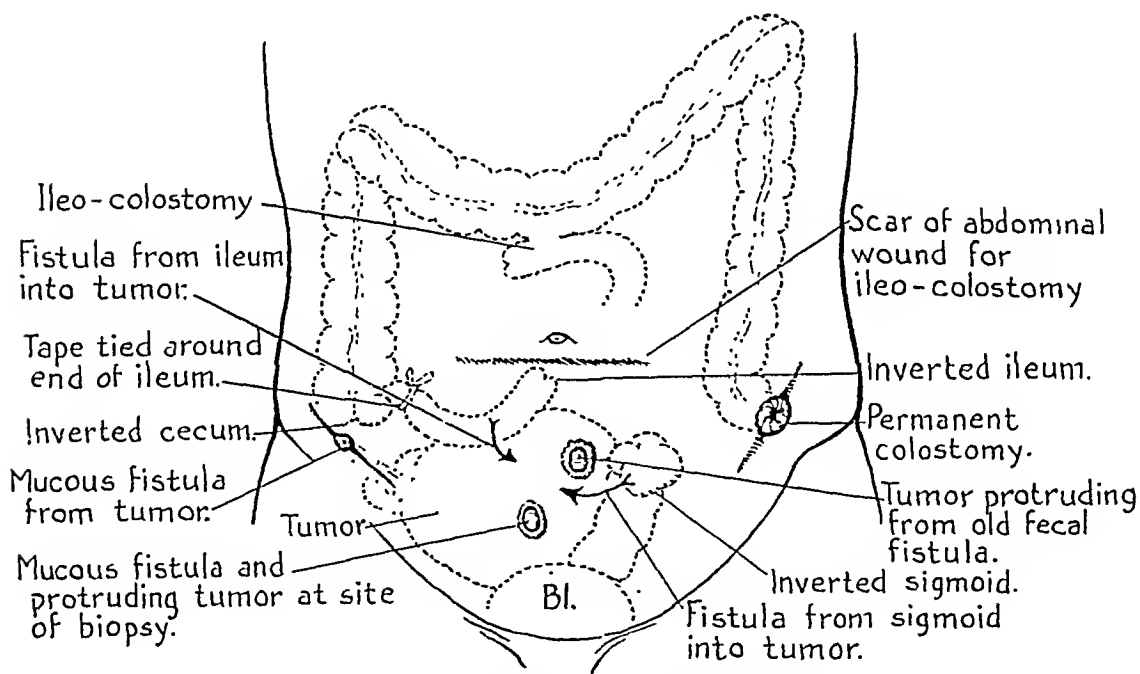


FIG. 3.—Fifth operation. Fecal flow cut off from tumor by permanent colostomy, ileo-colostomy and ligation of ileum near the ileocecal valve.

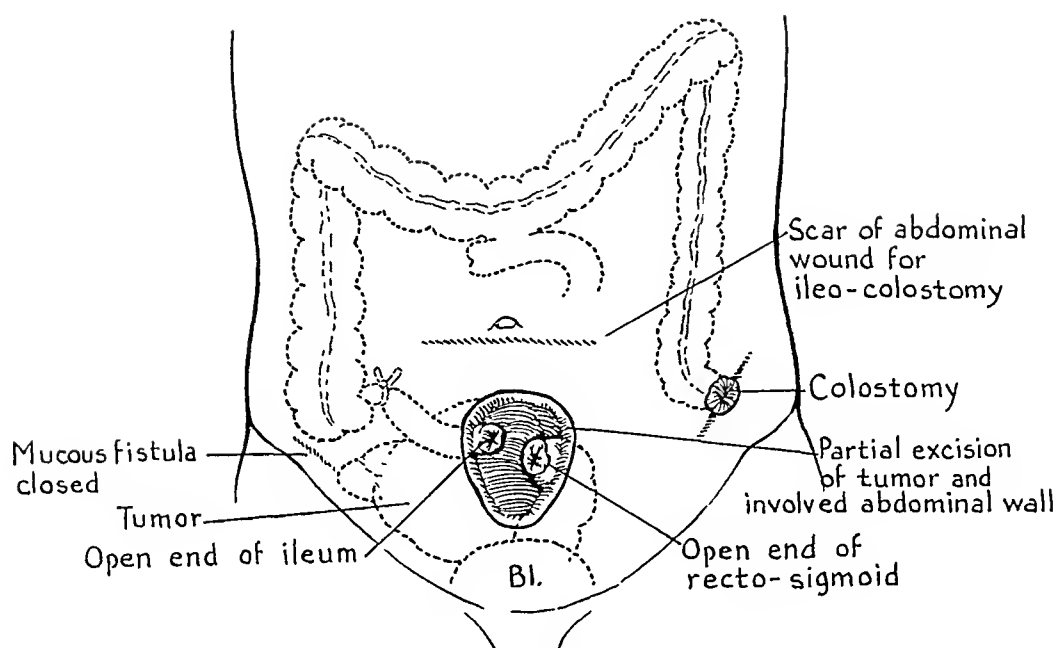


FIG. 4.—Sixth operation. Partial removal of tumor.

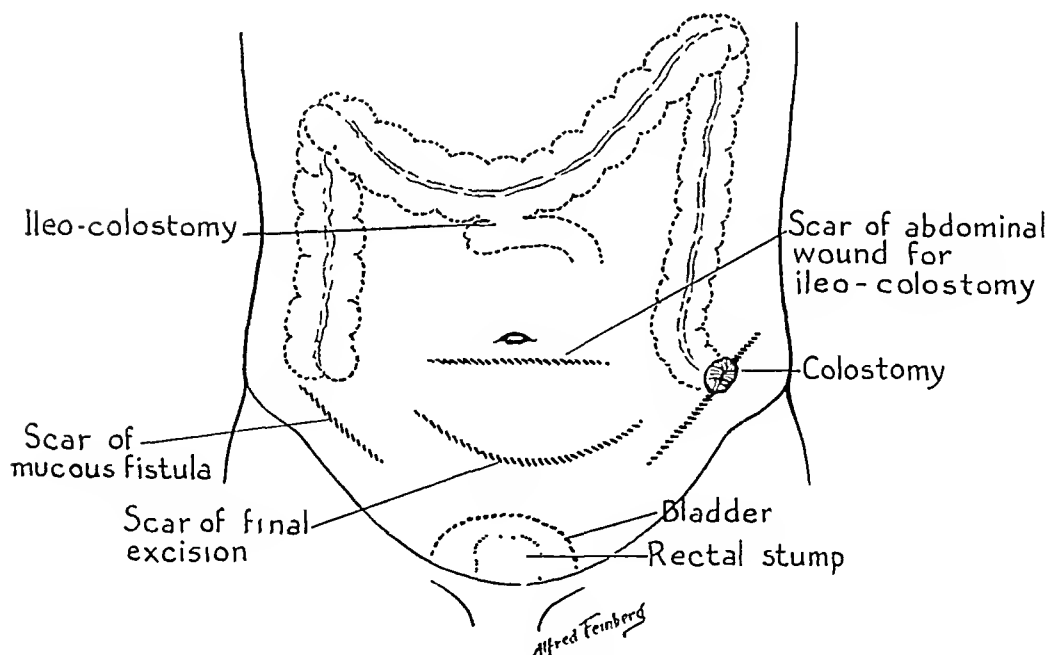


FIG. 5.—Complete removal of tumor. Showing the final anatomic relations

when it seemed as if a cancerous change had occurred; that is, as if the epithelium had invaded the underlying tissues. There was so much mucin that some of the epithelial cells were actually floating around in it just as they do in colloid carcinoma. This led to the supposition at one time that it had become cancerous, but the outcome seems to have proved that this was not so and that the case is actually one of pseudomyxoma of the peritoneum.

RUPTURE OF THE LIVER

FREDERICK CHRISTOPHER, M.D.

EVANSTON, ILL.

THE mortality in unoperated cases of rupture of the liver is probably about 80 per cent¹ and in operated cases about 60 per cent.² Reports of ruptures of the liver are not common, although it is regarded by some as the most frequently injured internal organ.³ Ruptures of the liver have been classified as: (1) rupture of the hepatic tissue and capsule; (2) rupture of the hepatic tissue without rupture of the capsule (subcapsular rupture); and (3) central rupture of the hepatic tissue.¹ Although in subcapsular ruptures, if they can be identified, operation is somewhat less urgent than in those cases where the capsule is torn in addition to the hepatic tissue, for general purposes it is probably wise to follow the advice of Moynihan,⁴ who believes that in suspected cases the need for operation is instant. Robertson and Graham⁵ report two cases of subcapsular ruptures of the liver and cite three others from the literature. In both of their cases the diagnosis was based chiefly upon the large epigastric tumor. The first case was successfully operated upon some 30 hours after the injury. The second case, in which the tumor did not appear until over two weeks after the injury, was not operated upon until 27 days after the injury when gross destruction of the liver tissue was found.

The following case presents several unusual features. First, there was a primary subcapsular rupture of the liver followed in less than 24 hours by a spontaneous rupture of the capsule on the operating table. Second, the subphrenic space became infected by a hemolytic *Streptococcus* requiring rib resection for drainage. Third, during the convalescence, the patient twice developed acute intestinal obstruction requiring laparotomies with prophylactic enterostomies.

CASE REPORT

K. N., aged 12, was admitted to the Evanston Hospital June 10, 1935, at 11:30 P.M. Three hours previously, while climbing a blunt wooden picket fence, she had fallen, striking her chest heavily against one of the pickets. A small abrasion just to the right of the xiphoid process marked the point of impact. When seen very shortly afterward she was suffering a great deal of upper abdominal pain, pulse 170, and was in considerable shock.

On admission to the hospital, the pulse was 100; temperature, 98° F.; and blood

pressure 135/70. The leukocyte count was 19,000; erythrocytes, 3,700,000; hemoglobin, 65 per cent. There was extreme tenderness and some rigidity of the upper right quadrant of the abdomen. Roentgenologic examination of the chest failed to disclose fluid and that of the abdomen in the vertical position gave no evidence of a pneumoperitoneum.

During the night the pulse rose steadily and at 8 A.M. was 150, weak and irregular. A tender mass, apparently liver, protruded four fingerbreadths below the costal border. At 9 A.M. the blood pressure was only 87/52 notwithstanding a hypodermoclysis of dextrose Ringer's solution which was in progress. Gum acacia solution, 1,200 cc., was given intravenously and by 11.30 A.M. the pulse was 130 and of good quality. A citrated blood transfusion (325 cc) was then given. At 12.30 the pulse was 110 and of good quality, the hemoglobin 44 per cent and the erythrocytes 2,990,000. The upper right quadrant now presented a marked rounded, tender swelling. The pulse having increased to 146 by 4 P.M., an exploratory laparotomy for rupture of the liver was determined upon.

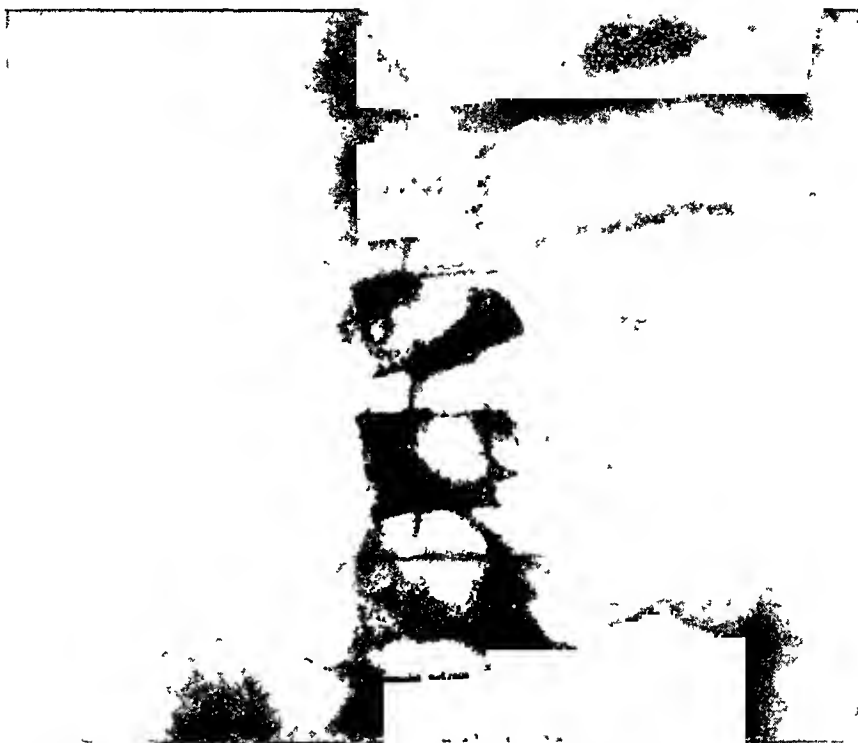


FIG. 1.—First intestinal obstruction. Note distended loops of small bowel.

Just before making the abdominal incision at 5:45 P.M. (June 11, 1935) it was noticed that the rounded swelling in the upper right quadrant had disappeared. On opening the peritoneum there was a gush of bright red blood. This was found to have come from a subcapsular hematoma which had involved practically the entire upper surface of the right lobe of the liver, and which probably had ruptured spontaneously after the anesthesia (nitrous oxide-ether) had been begun.

The right rectus incision was enlarged by cutting transversely across the right rectus muscle. From beneath the torn liver capsule handfuls of clots and large quantities of fluid blood were evacuated. The ragged surface of the liver parenchyma was felt over the entire upper surface of the right lobe up under the diaphragm. In the hurried palpation, no distinct fissure was recognized. The raw, bleeding surface of the liver was tightly packed with four large rolls of vaginal gauze packing. A 500 cc. blood transfusion was given during the operation. At its conclusion the pulse was 156, blood pressure 110/40, general condition satisfactory.

On the day following the operation the pulse rose to 166, temperature to 103.4° F. Blood and gum acacia were given intravenously and 5 per cent dextrose Ringer's solution was given subcutaneously. On the third postoperative day the pulse dropped from 160 to 120.

On the eighth postoperative day the gauze packing was removed and cigarette drains inserted. These were subsequently shortened and gradually removed. The patient improved rapidly and was sitting up on the twelfth postoperative day. On the fifteenth day, the patient began to have cramp-like abdominal pain and vomiting, which became worse the following day. By the seventeenth day the condition was much worse. The pain was more severe and the vomitus became dark brown. Roentgenologic examination of the abdomen (Fig. 1) showed a typical small bowel obstruction. A laparotomy for intestinal obstruction was performed. On opening the peritoneum a large quantity of thin blood-tinged fluid escaped. The small bowel loops which presented were markedly

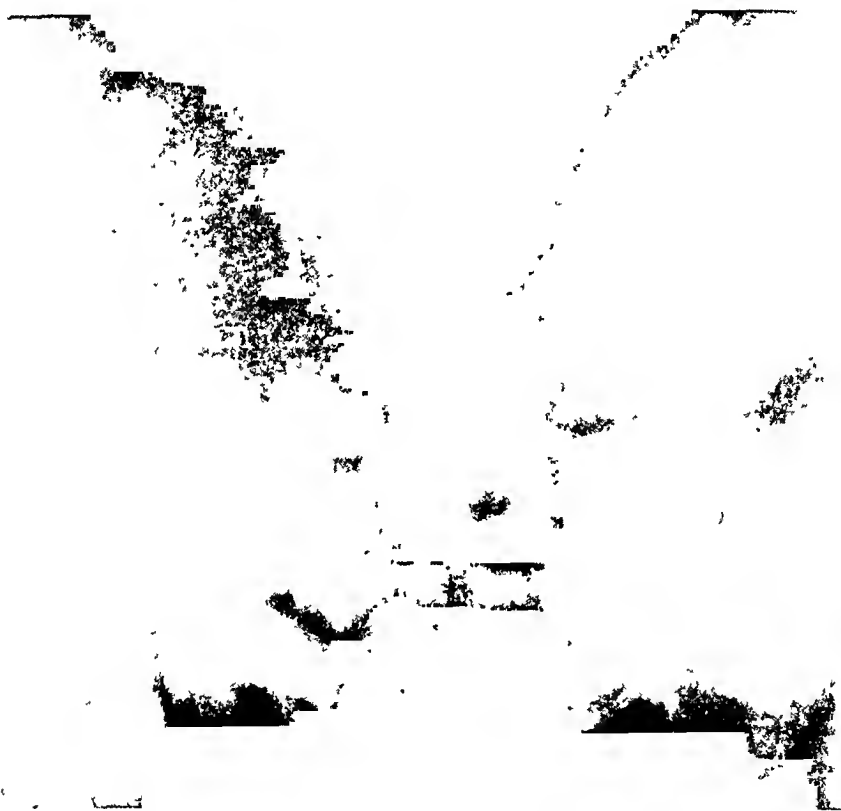


FIG. 2.—Second intestinal obstruction. Distended loops of small bowel are lower in the pelvis than in the first obstruction. The stomach contains gas.

distended and of reddish color. The obstruction was found high up on the right side near the ascending colon and was caused by a plastic adhesion. This was divided and a mushroom catheter enterostomy performed about eight inches proximal to the site of the obstruction. A nasal catheter connected to the Wangenstein suction apparatus was inserted into the stomach. On the twenty-second day (three days after the second operation) the patient became listless and the pulse and temperature increased. Some days previously the last of the cigarette drains had been removed and it was feared that a subphrenic infection and abscess formation might be taking place. The roentgenologist made an examination with the patient lying on her side, and found undue elevation of the right diaphragm and an air bubble in the right subphrenic region which suggested subphrenic infection or abscess due to an aerogenous organism.

On July 2, 1935 (the twenty-third day after the first operation), a third operation was undertaken. An incision was made over the tenth right rib in the anterior axillary line. Beginning at the costochondral junction an inch and one-half of rib was resected.

The visceral and parietal pleura were sutured and after positive needle aspiration an incision was made through the diaphragm. A cavity some 6 by 4 by 1 inches was found containing gray clots and old blood. Cultures showed a long chain Streptococcus. On the twenty-sixth day the bowels were functioning and the enterostomy tube was cut off, leaving the mushroom portion inside of the bowel to be passed.

On the twenty-seventh day the patient again began to have cramp-like abdominal pain and vomited. Roentgenologic examination (Fig. 2) again suggested small bowel obstruction. A blood transfusion of 500 cc. was administered and the fourth operation was performed (July 6, 1935). The distended bowel had a dark color and the obstruction was found to be on the right side, lower in the abdomen than the previous one but some 20 inches proximal to it on the small bowel. The obstruction, which was due to an adhesion, was corrected and a mushroom catheter enterostomy performed. Wangensteen nasal catheter suction was again instituted and continued for about 36 hours.

From this time on, convalescence was without serious incident. The thoracotomy cavity was irrigated until it finally closed. The second laparotomy wound became infected and the skin had to be incised on the thirty-seventh day (July 16, 1935) at which time the second enterostomy tube was removed. The child gradually improved and took a few steps on the fifty-eighth day. She was discharged from the hospital on the sixty-sixth day; the wounds healed entirely soon after. She gained rapidly in weight, and apparently is in perfect health.

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PATHOLOGIC FRACTURE THROUGH MYELOMA OF SHAFT OF FEMUR*

WILLIAM F. MACFEE, M.D.

NEW YORK

CASE REPORT

THE symptoms of this patient (No. 223,302), a white male, 45 years of age, married, began August 6, 1929, with a slight pain in the upper left femoral region which affected him only when he was on his feet and physically active. In the early part of September, 1929, while doing strenuous work, he was seized with a "mean" pain in the same region, so severe that he had to sit down. Following this he was treated symptomatically for a time but did not improve. A roentgenologic examination made several days later revealed a tumor in the upper left femur (Fig. 3A).

After a number of consultations he was operated upon October 14, 1929, by Doctor Bloodgood. At operation an extensive central lesion of the upper shaft of the femur was found. The tumor, described as a very bloody sponge-like mass, was curetted and cauterized. It proved to be a myeloma of the plasma cell type (Fig. 1).

* This case was originally reported by Dr. Charles F. Geschickter: Multiple Myeloma as a Single Lesion. *ANNALS OF SURGERY*, vol. 92, pp. 425-533, September, 1930. The present follow up report was read before the New York Surgical Society, April 24, 1935.

During convalescence very little new bone formation appeared and the patient suffered a pathologic fracture. Treatments with Coley's toxins were then begun and according to Doctor Bloodgood's report pain ceased almost immediately after the institution of this treatment. The formation of new bone was observed soon afterward. The toxins were continued over a period of about three weeks and were then stopped because the patient had a severe convulsion following an injection and refused further treatment. February 28, 1930, about four and one-half months after operation, the patient was permitted to leave the hospital on crutches. He was thought to have fairly good union at that time and returned to New York March 1, 1930. The next morning, while getting out of bed, there was a sharp, sudden "snap" in the upper left thigh with excruciating pain. He remained in bed and made no further attempt to move the leg.

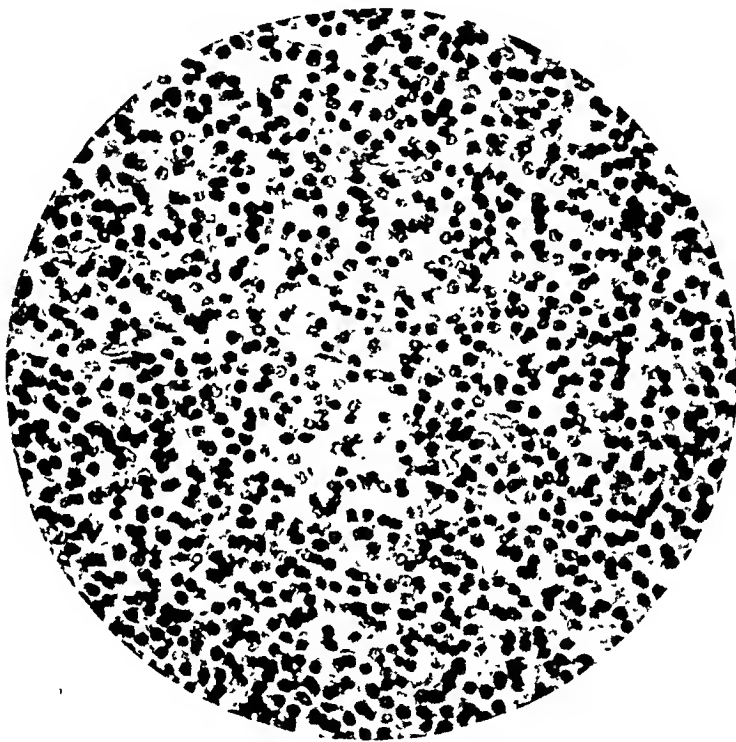


FIG. 1.—Photomicrograph of tumor. Myeloma of plasma cell type.

Examination revealed external rotation and about 4 cm. shortening of the left leg. There was a long scar over the lateral surface of the upper shaft of the femur with two sinuses which discharged thin, seropurulent material. At this level there was considerable external bowing of the femur. The patient appeared to be in great pain and there was marked tenderness.

A Thomas splint was applied and moderate traction maintained by the use of mole-skin adhesive straps. The patient was kept in bed at home for a few days until the acute pain and tenderness had subsided. On March 10, 1930, he was transferred to St. Luke's Hospital where roentgenograms showed a fracture of the left femur through what appeared to be a new growth just below the lesser trochanter (Fig. 3B).

Under the direction of Dr. F. C. Wood a series of 11 deep roentgen ray treatments were given between March 11 and June 30, 1930. Relatively small doses, 300 r, were given at weekly intervals. At the end of this period of about 15 weeks, roentgenologic examinations of the fracture showed union of the fragments. The patient was then fitted with a caliper type of brace and allowed to get about on crutches. He was discharged from the hospital July 7, 1930, about four months after admission. Roentgen ray therapy over the affected area has been repeated at intervals up to the present time.

No further foci of the disease were discovered until October, 1932. At that time

the patient complained of pain in the lumbar region and a radiogram showed some destruction of the body of the third lumbar vertebra (Fig 2A). Under deep roentgen ray therapy the pain disappeared and the lesion apparently healed. A roentgenologic study of the patient's skeleton made October, 1934 (Figs. 2B and 3C), revealed no suspicious areas except a rarefaction of the head of the right fibula.

The urine generally has been free of Bence-Jones protein. In November, 1934, however, the patient complained of thirst and polyuria and a urine examination made at that time revealed a large amount of the Bence-Jones protein.

The patient now has firm union with about 6 cm. of shortening. He was able to discard his brace and now, three years after the fracture, walks, usually with a cane, but sometimes without it. He has shown, however, a progressive anemia of the sec-



FIG 2.—(A) October 25, 1932, destructive lesion in body of third lumbar vertebra. (B) February 1, 1934, appearance following roentgen ray therapy.

ondary type, the last count being: red blood cells, 1,700,000; hemoglobin, 31 per cent; white blood cells, 6,000; polymorphonuclear leukocytes, 64 cent cent; large monocytes, 36 per cent.

Several remarkable features of this case deserve emphasis. First, the disease had at its onset and for a considerable length of its course but a solitary demonstrable focus of bone involvement. Second, both the initial and secondary lesions showed response and healing under irradiation despite a pathologic fracture. Third, the appearance of the secondary or new foci of the disease in the lumbar spine did not occur until three years after the initial lesion in the femur, and Bence-Jones bodies were not demonstrated in the urine until five years after the clinical onset.

DISCUSSION.—DR. WILLIAM B. COLEY (New York) called attention to a paper on multiple myeloma¹ in which he described 15 cases treated under his



Fig. 3—(A) September 14, 1929, the original lesion in upper shaft of left femur. (B) March 2, 1930, pathologic fracture. (C) October 16, 1934, firm union following treatment.

direction (including that just presented by Doctor MacFee) and quoted therefrom as follows: "That multiple myeloma is always fatal, and that no treatment is known of any value even in checking the progress of the disease, has been so universally accepted that the question of treatment is scarcely referred to in the very considerable literature on the subject. Geschickter and Copeland,² in a recent and most valuable monograph covering some 56 pages, devoted only six lines to treatment. They state that with no proved case reported as cured it is evident that palliative, symptomatic treatment only is available."

These two authors, according to Doctor Coley, overlooked the case of Dr. J. H. Thomas,³ in which an operation for a tumor of the dorsal spine had been performed, and a microscopic diagnosis of typical multiple myeloma made. The patient later developed metastases to the ribs and partial paraplegia. He was then under the care of Dr. Nathaniel Hunting of Quincy, Mass., who wrote to Doctor Coley seeking advice on the use of toxins. The condition was regarded as sufficiently analogous to round cell sarcoma to justify trying toxins, and the patient showed almost immediate improvement, all evidence of the tumors, as well as the paraplegia, gradually disappearing. The toxins were kept up, once or twice a week, for two years. The patient remained well for five years and then died of lobar pneumonia. There was no evidence of any recurrence of his former trouble at the time of his death.

In addition to the 15 cases reported in 1931, four additional cases of multiple myeloma had since been treated. While in the majority of cases the treatment (toxins alone or toxins combined with irradiation) has had only palliative or temporary effect, the results in these instances have been striking.

CASE REPORT.—L. L. A., a male, 56 years of age, had complained of pains in the lumbar and abdominal regions in 1923, for which he was given high-voltage roentgen therapy. In May, 1924, he was operated upon by Doctor deMartel of Paris for a malignant tumor of the dorsal spine. Extensive postoperative irradiation was given. He remained well until the early part of 1928, when he had a local recurrence with paraplegia and involvement of several ribs. He consulted Doctor Regaud of Paris, who did a biopsy in March, 1928. Sections of the tumor of the ribs were examined by leading pathologists of Paris and pronounced multiple myeloma. Doctor Regaud said that nothing more could be accomplished by irradiation and urged the patient to try Coley's toxins. Irradiation was continued but the condition grew steadily worse. The patient returned to America and in August, 1928, his local physician, Dr. Thompson Anderson, of Denver, Colo., consulted Doctor Coley with regard to using toxins. In view of the patient's condition (complete paralysis of the bladder, rectum and lower extremities, paralysis of one vocal cord, loss of 50 pounds in weight, and large bed sores), Doctor Coley did not encourage the use of toxins, believing that the disease was too far advanced to justify hope for improvement. Nevertheless, the patient insisted on a trial and toxin treatment was begun by Doctor Anderson under Doctor Coley's direction. Immediate and rapid improvement followed. In a few weeks, the patient was sitting up, and in a few months was able to get up. Roentgenograms of all the skeletal bones in September, 1929, failed to show any evidence of lesions. The patient had regained his normal weight and had returned to his work. He remained in good condition until the latter part of 1932, more than four years later, when his symptoms returned, and he died in January, 1933.

In September, 1929, Doctor Bloodgood learned of the result obtained in the foregoing case and asked Doctor Coley to send him some toxins for use in a case of solitary plasma cell myeloma of the femur with pathologic fracture, *viz.*, the case just presented by Doctor MacFee.

Although it would be impossible to estimate the part played by the toxins in controlling the disease in this patient over a period of more than five years, in view of the very small doses given (much smaller than advised) and the much too short term of treatment, Doctor Coley felt inclined to attribute the larger share of credit for the successful result to the roentgen therapy. Nevertheless, the only two cases reported of multiple myeloma that have remained well for a period of five years or more received Coley's toxins, one toxins alone, the other in conjunction with irradiation. A case of plasma cell myeloma more recently treated with toxins and roentgen therapy is well, two and one-half years later.

CASE REPORT.—P. McC., male, 39 years of age, caught a severe cold in June, 1932, and suffered pain all over his body. The cold cleared up, but not the pain. In the latter part of September, 1932, he was admitted to Bellevue Hospital, on the service of Dr. Alexander Lambert, where a diagnosis of multiple myeloma was made. Doctor Coley saw the patient in consultation and advised toxins in conjunction with roentgen therapy. The patient was transferred to Memorial Hospital November 14, 1932. Roentgenograms showed areas of bone destruction in the spine, ribs, skull and pelvis, together with bone alteration in the femora. The toxins started at Bellevue Hospital were resumed and the patient proved very susceptible. On December 14, he was placed in the Heublein unit where he remained for a period of two weeks, receiving continuous roentgen therapy all over his body. By January 29, 1933, he was feeling so well that he insisted on returning to his home in Ireland. When last heard from on January 14, 1935, he was in excellent health without evidence of recurrence.

In recent years three cases of solitary multiple myeloma have been treated by primary irradiation at Memorial Hospital:

CASE REPORTS

CASE I.—J. C., male, 48 years of age, had a solitary myeloma of the humerus. This was treated with radium pack in October, 1929. The patient developed a pathologic fracture in January, 1930, and died a few months later.

CASE II.—A man with a solitary myeloma of the femur of two or three year's duration was admitted in August, 1926. He was treated by Doctor Herendeen with irradiation, the lesion being held under control for three years, after which it grew worse and the patient died.

CASE III.—A patient with a like lesion of the upper femur that was held in check for two years, when it involved other skeletal bones.

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AN IMPROVED INTRAVENOUS ADAPTER

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FROM THE EMORY UNIVERSITY DIVISION OF GRADY HOSPITAL, ATLANTA, GA

AMONG all the unwelcomed accidents of a minor nature which may occur during blood transfusion or other intravenous therapy, perhaps none is more disconcerting and embarrassing to the operator than to have the needle unexpectedly leave the vein before completion of the procedure. An adapter which can be relied upon to prevent such annoying incidents is presented. This apparatus presents the following characteristics:

- (1) It is simple in construction.
- (2) It is standardized for use with the ordinary equipment found in any hospital.
- (3) It fits any surface.
- (4) It is easily and readily applied.
- (5) It allows no movement of the needle.

The instrument consists of two parts (Fig. 1). (a) The body which contains a straight central bore of caliber sufficient to accommodate the larg-

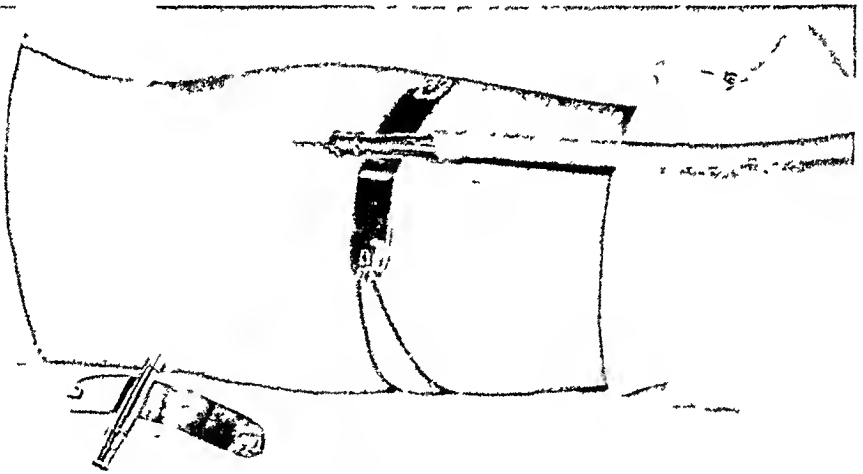


FIG. 1.—Showing adapter fitted to arm.

est needle; (b) a flexible base carrying two lateral projections or arms. This base can be easily molded to conform to any surface. It is held in place by a rubber band which engages each of two inwardly facing hooks and which encircles the forearm.

One end of the body fits any needle of standard size; the other end will admit an adapter or syringe. Annular heels are also provided to insure air-tight connection with rubber tube. The body is so constructed and applied to the base that the angle between the body and the base is such as to keep the end of the needle in the lumen of the vein and not allow it to come in contact with its wall.

Not only can this adapter be used with any type of transfusion apparatus, but it is equally available for use in connection with intravenous therapy of any sort.

AN IMPROVED CLAMP FOR THE MIKULICZ PROCEDURE

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SANTA BARBARA, CALIF.

THE Mikulicz method of extraperitoneal resection of the colon has resulted in decreased mortality from peritonitis and shock. In this procedure the portion of the bowel to be removed is brought outside of the abdomen and the general peritoneal cavity closed about the colon. Often the lumen of the bowel is not opened for 48 hours and peritonitis from fecal contamination should not occur. This multiple stage operation has extended this field of surgery to include the poorer risk patients, who previously would not have been subjected to an extensive one stage operation. These weaker patients can now safely undergo resection in stages.

Surgeons have been deterred from wider use of the Mikulicz procedure because of difficulty in reestablishing the continuity of the bowel. Most patients dislike even a temporary colostomy. When delay and difficulty are experienced in closure of the colostomy, both patient and surgeon are dis-

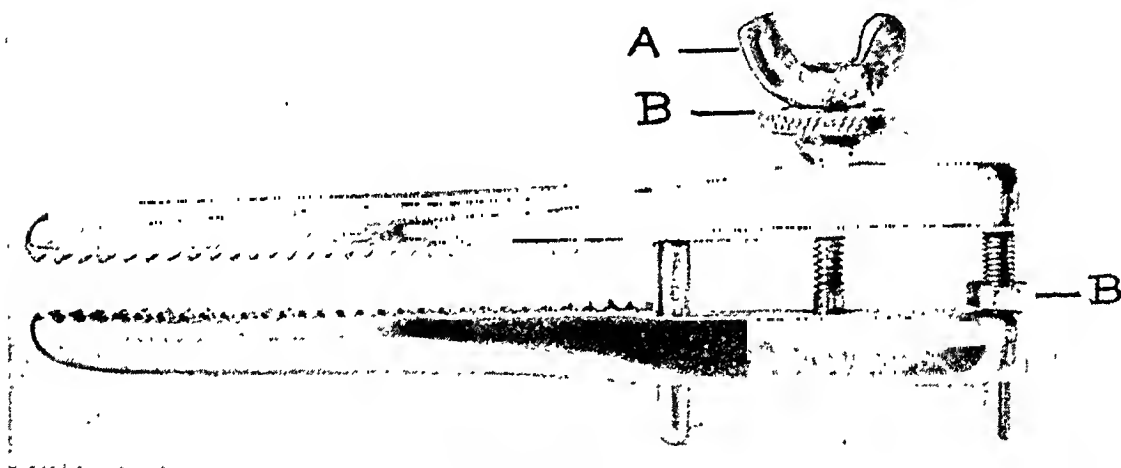


FIG. 1.—(A) Adjusting nut to keep jaws parallel and give equal pressure along jaws. (B) Lock nuts.

appointed and there is often a tendency on the part of the surgeon to do a one stage operation with greater risks from peritonitis.

We believe that much of the present dissatisfaction with the Mikulicz operation is from failure of the present methods to remove enough of the partition between the two limbs of bowel that form the colostomy. At the initial operation, two limbs of the colon on either side of the bowel to be removed are sutured parallel to each other for a distance of several inches. After the diseased portion of bowel has been removed, the septum formed by suturing these two limbs of colon must be removed. Enough of this bowel must be destroyed or the fecal stream will continue to appear at the abdominal stoma instead of following the normal route down the colon to the rectum.

We believe that the short narrow clamps now in general use have failed to remove enough bowel and are responsible for much of the present dis-

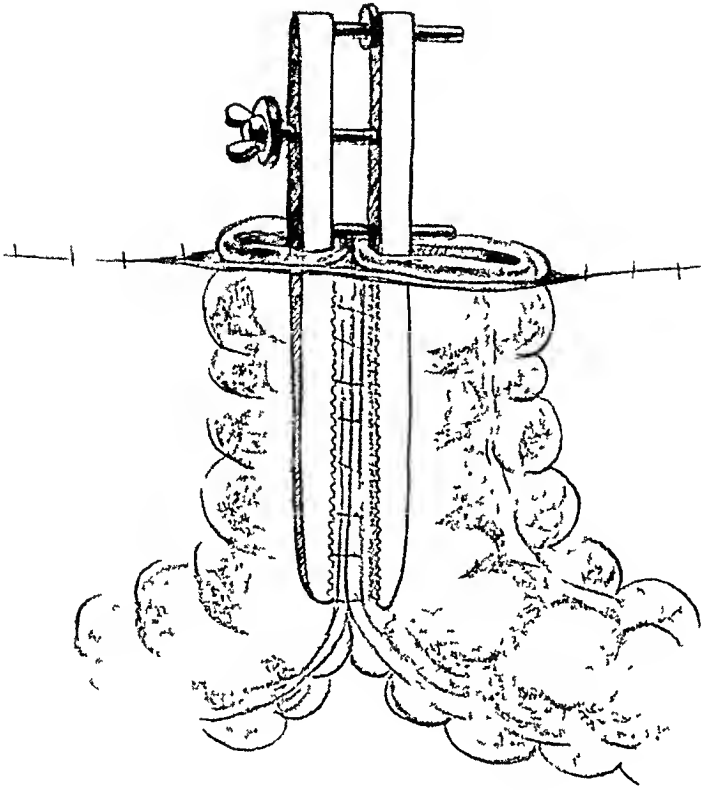


FIG 2—Mikulicz clamp in position.

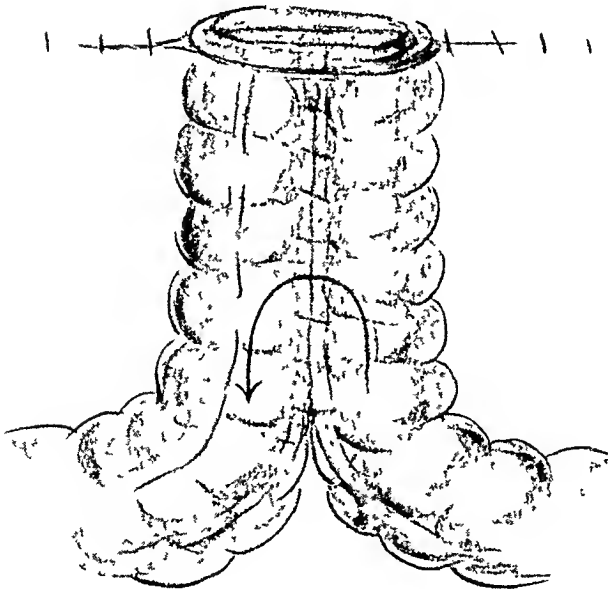


FIG 3—Clamp has come away. Showing resultant reestablishment of bowel continuity

satisfaction with this type of operation. The clamp described below was devised to remedy this difficulty, and we believe it is superior to the Kocher or kidney clamps now in general use. It is essential that the clamp have both long and broad crushing surfaces to destroy enough bowel by pressure necrosis. This clamp is five and one-half inches long with crushing surfaces three and one-half inches long and one-quarter of an inch broad and will destroy enough bowel, even in obese patients with thick abdominal walls, to restore the fecal stream to its normal channel. The jaws have a spread of one inch and the two blades come apart so that they may be inserted separately and then locked in position if this is desired. The teeth are deep enough to securely engage the bowel walls and when the clamp is applied the bowel will not slip. An adjusting nut provides a means of maintaining equal pressure along the crushing surfaces, regardless of the thickness of the bowel (Fig. 1).

This short clamp does not protrude a great distance above the abdominal wall, is not cumbersome, and is easily covered by an abdominal pad. This is a great convenience when the clamp is applied to ambulatory patients. Once applied, no further attention is necessary except to keep the lock nuts tight so that the septum of bowel will be necrosed (Fig. 2). This usually occurs from the fifth to seventh day when the clamp comes away voluntarily, leaving a wide and deep channel for the fecal stream (Fig. 3). If closure of the colostomy is then desired, it may be done immediately by one of the accepted methods now in general use.

I am indebted to Mr. Sam Crist of the Engineering Department of the Cottage Hospital for his aid and technical suggestions in constructing this clamp.

MASSIVE HEMORRHAGE FROM POSTERIOR DUODENAL ULCER*

DAMON B. PFEIFFER, M.D.

PHILADELPHIA, PA.

CASE REPORT.—J. P., male, 58 years of age. Thirty years ago he complained of symptoms characteristic of ulcer; *i.e.*, discomfort about two hours after meals, relieved by food or alkalies, belching of gas and sour material, with periods of remission and freedom from symptoms. On October 22, 1919, he was admitted to the Lankenau Hospital on the service of Dr. John B. Deaver. For three to four years previously he had noticed that his stools were black at times and he would occasionally vomit coffee ground material. Three days before admission he vomited some blood and fainted. Recovering consciousness he had a similar attack three hours later, vomiting a teacupful of bright blood, and again fainted.

On admission he was obviously exsanguinated. His physical examination was otherwise negative. A diagnosis of bleeding gastric or duodenal ulcer was made and he was placed on a medical regimen under which he improved rapidly.

Eleven days later, Doctor Deaver operated upon him. The stomach, duodenum,

* Read before the Joint Meeting of the Philadelphia Academy of Surgery and the Boston Surgical Society, February 4, 1935.

gallbladder, liver and spleen all appeared normal. The stomach was opened and explored but no lesion found. The appendix, which showed a chronic condition, was removed.

Eleven months later he was readmitted with recurrence of gastric symptoms and black blood in his stools. Roentgenologic examination showed some constriction of the duodenum, thought to be due to adhesions. The stomach emptied completely in four and one-half hours. Bearing in mind the previous negative exploration, a tentative diagnosis of purpura hemorrhagica intestinalis was made and medical treatment instituted. His symptoms disappeared, the bleeding stopped, and the follow up five months later found him well.

His history from that time on may be abbreviated as one of intermissions with complete absence of symptoms interrupted at intervals of 6 to 12 months by periods of gastric symptoms with melena and gastric hemorrhage.

When first seen by the author in October, 1933, he had been well for many months, until two weeks before admission to the Abington Memorial Hospital, when his stomach symptoms had returned in severe form, followed two days before admission by vomiting of coffee ground material and on the day of admission by a severe gastric hemorrhage of a quart and one-half of bright, red blood. His hemoglobin was 62 per cent; red blood cells, 2,930,000; white blood cells, 21,600; coagulation and bleeding time, normal. Blood continued to be present in his stool and ten days later his hemoglobin had fallen to 52 per cent, but the red blood cells were still 2,920,000 and the white blood cells had fallen to 7,000. His general condition seemed much improved. Roentgenologic examination showed complete emptying of the stomach in six hours and no persistent defect of the stomach or duodenum. It was thought that he had a chronic posterior ulcer of the duodenum. Eight months later his gastric symptoms returned and he had a severe hemorrhage by mouth and bowel for which he was readmitted to the Abington Hospital in a condition of marked exsanguination. His hemoglobin was 34 per cent; red blood cells, 2,140,000; white blood cells, 19,500. He was given fluids parenterally and a transfusion the following day.

On June 8, 1934, his abdomen was reopened through the former scar and dense general adhesions encountered, involving the pyloric portion of the stomach and the duodenum. These organs with the transverse colon and the gallbladder were bound together and to the inferior surface of the liver. There was no evidence of cirrhosis. The spleen was not enlarged. There was no diverticulum of the small intestine. The gallbladder was dissected free from enveloping adhesions. It was not inflamed and contained no stones but it was thought best to remove it. No lesion was found in the stomach. The duodenum was then freed and no sign of disease found on the anterior wall nor could a crater be detected on the posterior wall. At a point just about opposite the right border of the gastrohepatic omentum, an area of inflammatory infiltrate was found and it was decided to open the duodenum to inspect its interior at this point. This revealed a large ulcer, almost one inch in diameter, on the posterolateral wall. In its bed could be dimly seen a vessel passing from above downwards. The ulcer bed was partly in the pancreas and extended upwards and to the right where the duodenal wall was guarded by the attached gastrohepatic omentum. It had eroded through the entire thickness of the duodenum and it was thought to be in intimate relation to the common duct. Safe excision seemed out of the question. As we have learned that gastroenterostomy frequently fails to relieve such a situation, it was decided to destroy the vessel with the actual cautery, to lightly cauterize the remaining ulcer bed and to perform a wide pyloroplasty to check the bleeding and to create conditions that would favor healing under an ulcer regimen (Fig. 1). He made an uncomplicated recovery and has been symptom free since.

Follow Up.—February 12, 1936. The patient is now symptom free and has had no further bleeding, the longest period without hemorrhage, since his original operation 16 years ago.

It is too soon to say that this procedure will be permanently effective.

HEMORRHAGE FROM DUODENAL ULCER

He has had other long remissions. He illustrates, however, some of one's difficulties and perplexities. Just what to do with this type of ulcer, fortunately rare, is not a subject for dogmatism. I seriously doubt if these low chronic posterior ulcers heal under medical management. When they bleed recurrently as this one did they certainly become surgical. Possibly gastro-enterostomy by its change of chemistry and partial diversion of gastric contents, combined with medical measures, will sometimes bring about healing

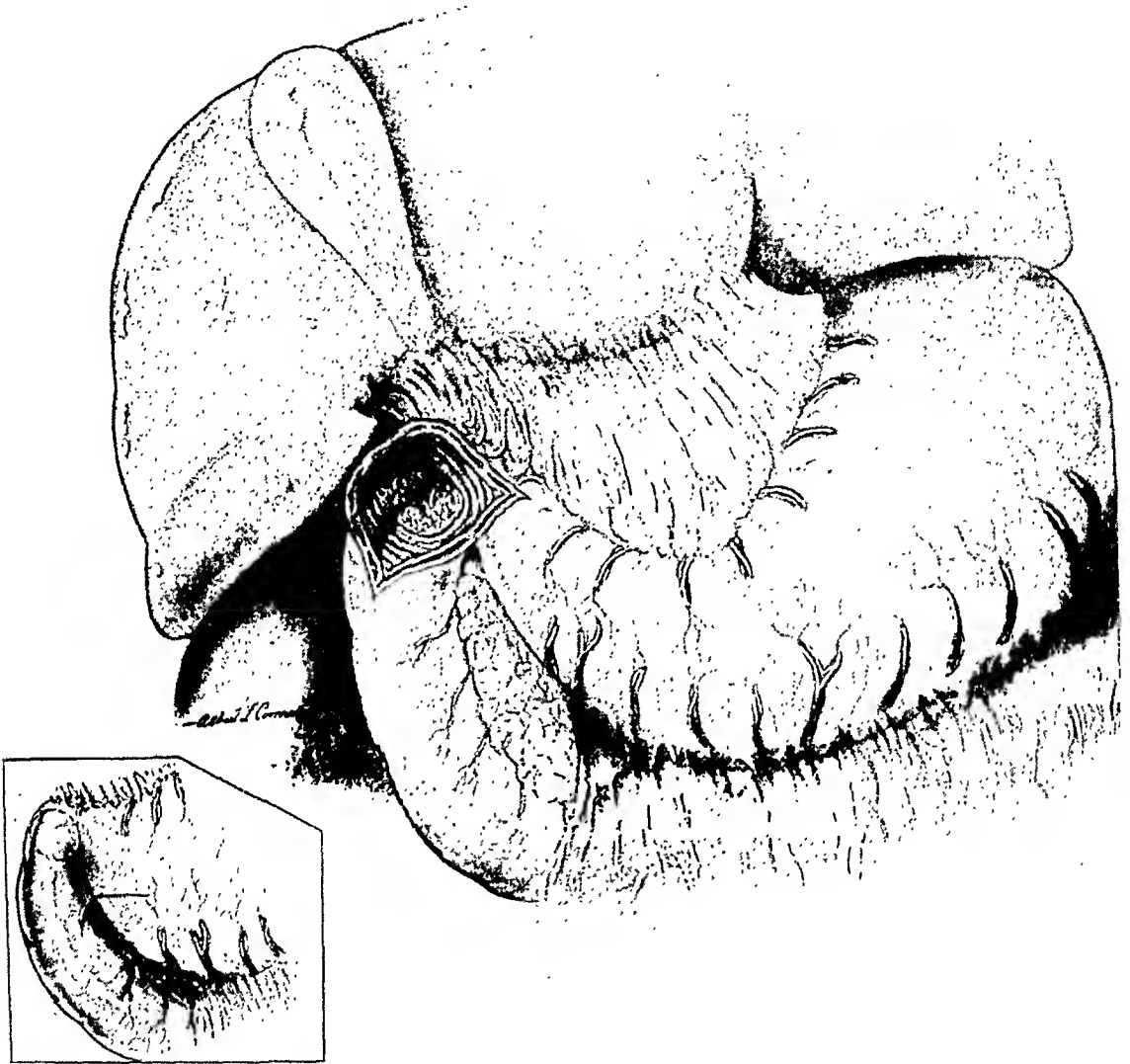


FIG. 1.—Approximate position and size of posterolateral ulcer. Inset shows large gastroduodenostomy with arrow suggesting probable diversion of gastric contents away from ulcer bed.

of the smaller and less indurated lesions but it is not reliable and introduces the danger of gastro-enterostomy complications. When the ulcer is fairly high and small it may be possible and preferable to excise the involved portion of the duodenum, but in the cases that I have seen such an attempt is fraught with great danger. Simply to open the duodenum and ligate or cauterize the bleeding vessel may check the hemorrhage but would seem to offer little towards cure. Several years ago I thought that the Devine procedure would short circuit the ulcer and permit healing under permanently alkaline conditions in the duodenum, but after encountering jejunal ulcer following this operation I became skeptical of its value. It

now seems to me that it is worthwhile to attack these ulcers directly through the opened duodenum. The smaller ulcers may at times be excised and partly closed. The larger ones may be cauterized and their margins nicked as chronic ulcers have been treated from time immemorial. Naturally caution must be employed in this cauterization. Then a large pyloroplasty is made both because such a closure is safer than a simple suture of the duodenum and because thereby a free interchange of gastric and duodenal contents is established, and thus alters the chemistry of the stomach juices and also a certain diversion of the course of gastric contents is accomplished which may favor the natural healing efforts of the tissues. I now have a few cases of this kind under observation in whom the results up to date seem highly satisfactory. Medical management following operation is of course obligatory.

It is my opinion that this plan will result in cure in a considerable number of these difficult cases without undue surgical risk and that the more resistant cases may be excised more safely after this preliminary attack, if it be found necessary.

DISCUSSION.—DR. DAVID CHEEVER (Boston, Mass.).—It seems to me that this problem is so difficult and unsettled that I predict that 20 years hence the discussion of peptic ulcer will be equally interesting because it seems to me that it can never be standardized. We all look with envy on the statistics from some clinics which report 85 to 90 per cent of five-year cures of peptic ulcer either gastric or duodenal by simple gastrojejunostomy. We all have immediate satisfactory results after these operations but subsequently many of us have such a high percentage of marginal and duodenal ulcers at or near the stoma that we have become discouraged. There is therefore a widespread conviction that peptic ulcer should be submitted to a long medical regimen before being subjected to surgery. Doctor Pfeiffer's most interesting case brings up one of the greatest dilemmas which we face: What to do when confronted by massive hemorrhage from the upper alimentary tract? There are a number of very interesting things brought out by the story of his patient which might be emphasized. One is that massive gastric hemorrhage, if not due to ulcer, could probably be readily explained by simple exploratory operation. Therefore if we operate in such a case and do not at once find the explanation, we are certainly justified in making a very extensive exploration of the stomach and duodenum as Doctor Pfeiffer did. In this connection it is well to be reminded of the possibility of hemorrhage from the gastro-intestinal tract due to the ulceration of ectopic gastric mucosa in a Meckel's diverticulum. Doctor Allen, of Boston, has studied and contributed largely in an important way to the treatment of massive hemorrhage from peptic ulcer and his decision, as I understand it, is that in these cases the thing to do is not to wait too long in the hope that hemorrhage will cease spontaneously but to transfuse the patient, open the stomach and duodenum freely, in order to find the bleeding point. Then to resect the pylorus and first part of the duodenum and restore continuity, either by direct anastomosis or by gastrojejunostomy. I do not believe that it is ever possible permanently to stop this hemorrhage by local treatment of the ulcer after opening the viscus—that is, by cauterizing the base of the ulcer or by direct ligation. This simply will not succeed because after temporary arrest the gastric juice will digest away the ligature and the clot and bleeding will start up again. Another thing, we must not be too em-

phatic in our teaching that most cases of massive hemorrhage from peptic ulcer will recover if submitted promptly to medical treatment. Within a week or two I have seen a bleeding duodenal ulcer treated medically without avail and then subjected to transfusion with benefit but with final secondary hemorrhage and death. Formidable though the prospect is we ought early to feel the obligation to explore cases of persistent or massive hemorrhage presumably from ulcer. Drastic operation is justified in that type of case. My preference, in spite of Doctor Pfeiffer's experience with marginal ulcer, would be to divide the pylorus, resect it if reasonably feasible but at any rate to turn the ends in and restore continuity by gastrojejunostomy. It is my opinion that by diverting the acid gastric contents from the ulcer it will heal without the necessity of actual excision, though it is doubtless desirable.

DR. E. L. YOUNG, JR. (Boston, Mass).—We see cases done by all of the different surgeons at all periods and with all types of surgery and I think we have come to formulate the conditions as follows: Duodenal ulcer as such is a medical and not a surgical disease. The complications are surgical only because we are either dealing with an unknown disease, of which the ulcers are the outward manifestation, or else we are dealing with a disease of multiple etiology, in which we cannot know the etiology in every case and can only treat the manifestation. We feel that surgery is indicated only in four conditions: (1) perforation; (2) pyloric obstruction; (3) hemorrhage; (4) that case disabled by pain or where symptoms of the ulcer are such that the patient cannot continue his or her occupation.

Regarding the hemorrhage, I think there are two or three things which are of importance. First, the age of the patient and second, the severity of the hemorrhage. Dr. Arthur W. Allen, in reviewing these cases at the Massachusetts General Hospital recently, found that in patients under 50 the primary hemorrhage was rarely fatal. The older the patient the greater the danger. The more hemorrhages there have been, the more of a risk. Consequently, we feel that those patients who have had a massive hemorrhage and recovered without operation or those who show evidence of repeated bleeding should be offered radical surgery; *i.e.*, resection of the pylorus and the turning back of the duodenum, and the tying of the blood supply from the posterior side. He told me he has had up to date 31 such cases without a single death. Twice in the past year I have performed radical surgery, once being forced in on account of acute hemorrhage; and both of these cases showed only very small ulcers of the anterior wall.

MEMOIR

AUGUST FREDERICK JONAS

1858-1934

AUGUST FREDERICK JONAS was born at Arlington, Wisconsin, in 1858. He died from cerebral hemorrhage at his home in Omaha, Nebraska, on November 12, 1934. Seven years previously he had suffered from a small cerebral



AUGUST FREDERICK JONAS, M D

hemorrhage which left an aphasia which caused his retirement from active work.

He was graduated from the Bennett Medical College in Chicago in 1877 and took up general practice in Wisconsin. In 1882, he went abroad and studied in Vienna, Berlin and Paris for a short time and then entered the Ludwig Maximilian University in Munich as a student and was graduated in 1884.

Returning to his home state of Wisconsin he again carried on a general practice until 1887 when he moved to Omaha and became connected with the Union Pacific Railroad, eventually becoming Chief Surgeon of the road and holding this position for 29 years, until his retirement because of his ill health. He served also as division surgeon for the Chicago and Northwestern Railroad and as assistant surgeon for the Chicago, St. Paul, Minneapolis and Omaha Railroad.

Being interested in teaching, Doctor Jonas joined the faculty of the Omaha Medical College as Professor of Clinical Surgery in 1892. In 1899, he added to his duties as a teacher the responsibilities of the deanship of the college and remained in that position until 1902 when the college was merged with the Medical Department of the University of Nebraska. He remained as Professor of Surgery and Chairman of the Department until his retirement in 1929, when he was given the appointment of Professor Emeritus. In 1927, he received the degree of Doctor of Laws from the State University.

Doctor Jonas was a member of many medical societies and was a conscientious attendant at meetings. He contributed to the societies by reading papers, entering freely into discussions, and serving in an official capacity when called upon. He was elected a Fellow of the American Surgical Association in 1901 and served as vice-president in 1906. He was a member of the Société Internationale de Chirurgie. At one time he was vice-president of the American Medical Association. He served for five years on the Board of Governors of the American College of Surgeons. He was president of the Western Surgical Association in 1901 and at various times served as president of the Missouri Valley Medical Society, the Nebraska State Medical Society and the Omaha-Douglas County Medical Society.

Doctor Jonas was essentially a clinical surgeon. Coming to Omaha in the early years of the city he identified himself with the surgical progress of the Middle West and gave of himself unsparingly to the efforts of the community to found hospitals and establish a medical college which would be a credit to scientific medicine.

Doctor Jonas' contributions to medical programs were concise, simply stated and written in a way to be understood readily. As he was an accomplished linguist, speaking both French and German almost as well as he did English, his acquaintance with foreign surgical literature was considerable and he added to his understanding of foreign methods by frequent trips abroad and personal contact with leaders in surgery.

As a teacher Doctor Jonas was highly respected by his students. His command of words was such that he was an adept in explaining the points that he wished to emphasize in such a way as to make the subject easily under-

standable. Consequently his clinics and ward rounds were well attended and popular with his students.

During the World War Doctor Jonas was commissioned Captain in the Medical Reserve Corps. He was active in organizing an ambulance company connected with Base Hospital No. 49 and acted as medical adviser to the Governor of Nebraska on military matters.

Doctor Jonas was a great believer in travel as a means of education. He regularly took a vacation each year and traveled to many parts of the world. On these trips he gathered material which appealed to his many interests. His collections, though not large, were brought together with discrimination, and are of great interest. They include paintings, Chinese jades, objects from the tombs of old Egypt, Alaskan Indian material and a large collection of geologic specimens from many countries. The acquisition of these collections enlarged his interests and made him a man of broad culture well grounded in many fields outside of his own science.

It is given to but few men to leave as great an impress on the community in which they lived as did Doctor Jonas. He came to a young and growing part of our country and by constant striving and continued hard work became an integral part of it and did much toward raising the standard of surgery during its period of rapid growth.

Doctor Jonas is survived by his widow, two sons and a daughter. His eldest son, August Frederick Jonas, Jr., is at present one of the residents in the Department of Surgery at Johns Hopkins University.

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Kansas City.

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THE SURGICAL TREATMENT OF SYRINGOMYELIA*

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FROM THE NEUROSURGICAL CLINIC OF THE HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.

AMONG the less common diseases of the spinal cord, syringomyelia occupies an important place. Pathologically, the process is characterized by two changes occurring usually within the cervical cord: (1) Gliosis or a slow proliferation of the supporting glial cells, and (2) cavity formation. The latter is of particular interest to the neurosurgeon. The relative extent of each varies greatly in different cases though both are usually present. While the exact etiology of the disease cannot as yet be conclusively settled, it is probable that it depends primarily upon developmental anomalies of the glial cells along the posterior median raphé of the spinal cord. These abnormalities are doubtless present at birth. Possibly as the result of irritation or trauma, a slow proliferation of the glial cells begins in later life, and in the course of the growth of the lesion secondary degeneration occurs within it and a cavity lined and surrounded by glia is formed. The boundary between intramedullary gliosis and intramedullary gliomas is not always a sharp one, and syringomyelia has been considered by many writers as a neoplastic process, to be differentiated from the usual tumors only by its very slow extension.

Clinically, the patient presents the picture of a slowly developing sensory and later motor loss usually beginning in one upper extremity and accompanied not infrequently by severe aching pain in the neck and shoulders. The location of the pathology in the central portion of the cord produces a characteristic associated sensory change with preservation of touch in areas where pain and temperature stimuli are not perceived. Early in the disease, muscle atrophy and vascular and trophic changes can be detected in the affected extremity. While peculiar remissions and relapses may occur, the symptoms slowly progress, and appear in the lower extremities and opposite side in time. The extension of the disease into the medulla is also not uncommon.

From the standpoint of surgical treatment, two features of the disease deserve emphasis: (1) the progress of syringomyelia both pathologically and clinically is extremely slow, and (2) in many cases a large share of the symptom-complex may be the result of compression of the spinal cord between the distended cavity within and the bony walls of the spinal canal with-

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out. Consequently, if an artificial communication between the intramedullary cyst and the subarachnoid space can be established and this pressure released, great improvement will occur in these patients; an improvement, moreover, which will be maintained for a number of years.

We have in our files the record of a number of operations for syringomyelia; the first operation was performed May 31, 1922, and the last July 31, 1934. Altogether, there were five patients and eight operations; three patients were operated upon at intervals of nine months to two years. Of the five patients, we have been able in three to follow the clinical course from the date of operation to the present time. One patient was operated upon in 1931, but we have been unable to trace him. In one patient, the syringomyelic process was complicated with an internal hydrocephalus and papilledema. Believing the patient had an intracranial lesion, an exploratory craniotomy was performed to which the patient succumbed. The autopsy revealed a syringomyelic cavity of the cord and the internal hydrocephalus proved to be due to a block of the fourth ventricle (Alpers and Conroe).¹ In one case, what was believed to be essentially a true syringomyelia proved later to be a glioma which had undergone cystic degeneration. In several recent cases, too little time has elapsed to evaluate the results. There were no operative deaths in the series.

Our knowledge of the efficacy of surgical measures in the treatment of syringomyelia obviously must depend upon the observation of the patients for at least one year, preferably longer. Unfortunately, the majority of the reports of surgical experiences include only a relatively brief postoperative period. To evaluate the propriety of open drainage, it is essential to consider only late results. With this object in view, two of the five operative cases of this clinic with relatively long periods of observation have been reviewed. Fourteen additional cases in which the period of observation after operation was one year or more have been collected from the reports of other clinics, and the technic and results of the operation will be the subject for discussion.

CASE REPORTS

CASE I.—R. S., white female, aged 35 years (No. 18559), was admitted to the Neurosurgical Service of the University Hospital, April 2, 1930.

Summary.—A woman of 35, who slowly developed all of the characteristic neurologic changes of syringomyelia, was first operated upon with drainage of a cervical intramedullary cavity in 1930. She subsequently had less pain and was completely relieved of a distressing incontinence, but almost two years later developed bulbar symptoms which were relieved by a second drainage in 1933. Her improvement after this operation was well maintained for almost two years. Recently, occasional bulbar symptoms have again appeared.

NOTE.—This case was previously reported (1930, 1933) but is again reviewed for two reasons: (1) Because the preoperative duration of symptoms is longer than in any other reported case, and (2) because it represents an instance of prolonged benefit (four and one-half years) from operation, despite the duration of the lesion.

History.—When first seen, this patient gave a history of 15 years' duration. In 1915, she first observed a tingling sensation in the left arm, followed shortly by a progressive loss of sensation and motor power in both left extremities. The right arm began to show a decrease in strength in 1919, but loss of sensation in this area

did not appear until almost one year later. The progression of these symptoms was very slow from 1928 on, but in 1929 two additional difficulties appeared—clonic spasms of the muscles of the neck and the right shoulder and occasional incontinence of urine. Early in 1930, paresis of the right leg developed and the patient also began to complain of trouble in focusing her eyes.

Examination on Admission in 1930.—At this time, examination showed a marked loss of motor power, the left arm being completely paralyzed and the left leg and right arm about 75 per cent incapacitated, and the right leg slightly below normal in strength. The patient could barely walk a few steps with much assistance. The sensory changes were likewise extensive—all forms of sensation being lost from the face down, with the exception of the left leg, where touch, pain and temperature stimuli were faintly detected by the patient. The face showed a bilateral dissociated sensory loss; touch being preserved and pain and temperature senses much reduced. The extremities, particularly the left shoulder, were atrophied, and spastic contractures were beginning. Hyperactive tendon reflexes, ankle clonus, and a positive Babinski sign were found bilaterally in the lower extremities. Examination of the cranial nerves was negative with the exception of the sensory changes in the face and a marked nystagmus on deviation of the eyes in any direction. Lumbar puncture revealed a spinal fluid pressure of 250 Mm. of water, but curiously enough the Queckenstedt test showed no evidence of a subarachnoid block.

First Operation.—April 14, 1930.—A cervical laminectomy exposed a swollen spinal cord which was incised on the dorsal aspect 1 to 2 Mm. to the right of the midline. At a depth of 2 to 4 Mm., a large cystic cavity was entered, permitting the escape of a considerable amount of fluid. A small gutta percha drain was inserted into the cavity and the dura and remaining layers closed with interrupted silk sutures.

Interval History, 1930–1933.—As had been feared preoperatively there was no great alteration of the long-standing motor and sensory picture. Nevertheless, definite results were obtained, including the relief of spasticity in the hands, a slight improvement in the power of the right side and restoration of touch and temperature sensations in the second and third cervical and in the trigeminal zones. Most encouraging of all, however, and of the greatest importance to the patient, was the complete relief of urinary incontinence.

During the next two and one-half years, the patient's condition changed very little. There was, however, a gradual progression of the weakness of the right extremities, associated with occasional attacks of clonic jerking, for which two series of roentgen ray treatments were given with very little effect. In January, 1933, a rather rapid downhill course began. Ptosis of the right eyelid, huskiness in talking, twitchings of the right side of the face, and attacks consisting of a sense of constriction about the chest associated with labored and irregular respirations, cramp-like pains in the left leg and abdomen appeared.

It seemed probable that there had not only been a rostral progression of the process into the brain stem, but that the syringomyelic cavity had refilled. To confirm the latter hypothesis a needle was introduced through the site of the laminectomy, first into the subarachnoid space and then slightly deeper into the cavity in the spinal cord. Nine cc. of clear fluid containing 10 cells per cc. (as compared with two cells per cc. from the spinal fluid) were evacuated.

Second Operation.—February 2, 1933.—Since the aspiration resulted in slight improvement in the patient's condition, a second cervical laminectomy was proposed. The cervical cord was found to be widened but collapsed (presumably as the result of the evacuation of the cyst by aspiration a few days before). Not the slightest clue as to the site of the previous incision could be detected. However, when an incision 2 cm. in length was made in the spinal cord slightly to the right of the midline, the gutta percha drain of the first operation was discovered partly in the cyst and partly in the wall, though completely covered apparently in part by arachnoid. As far as could be determined grossly, closure of the first drainage opening into the cavity had followed dis-

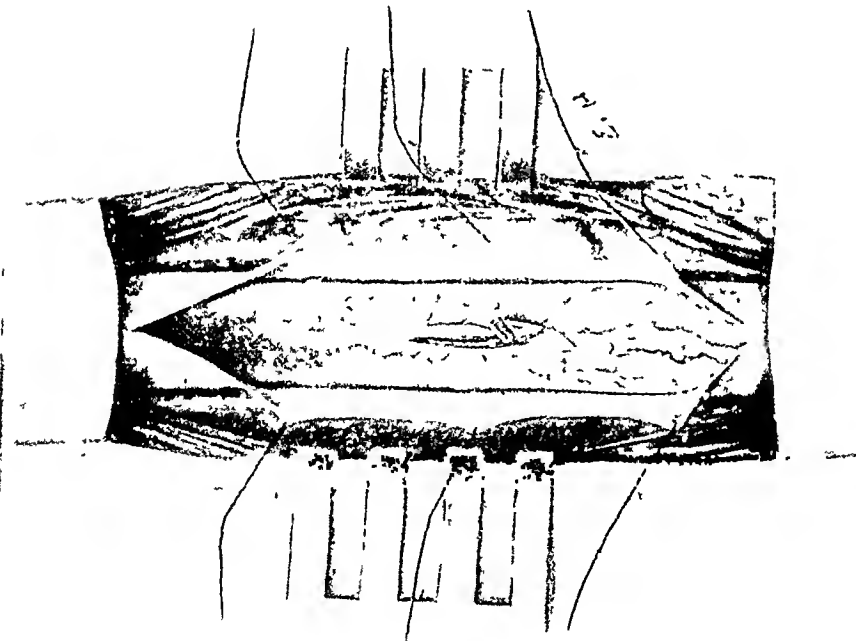


FIG. 1.—The appearance of the spinal cord in Case I after the second operative drainage, showing the collapse of the cord, the incision into the cyst, and the gutta percha drain held in place by one silver clip.

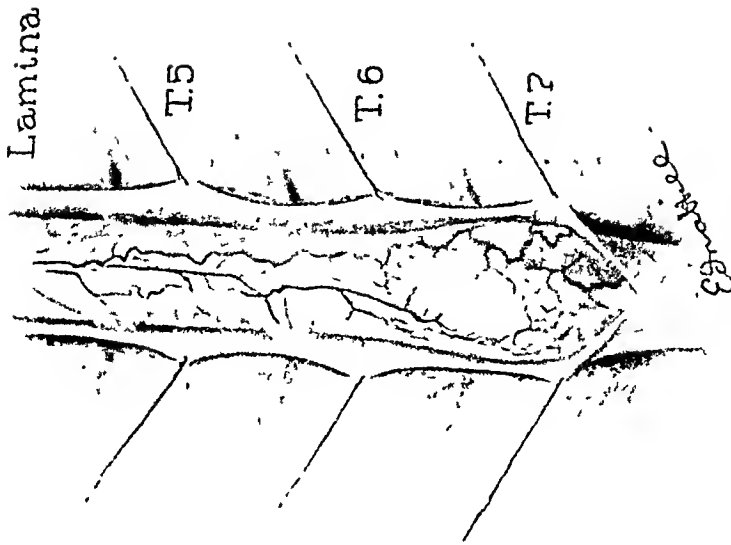


FIG. 2.—The spinal cord as it appeared at the first operation in Case II, showing the marked swelling at the seventh cervical segment.

lodgment of the gutta percha drain into the cavity and a subsequent gliosis and adhesion of the arachnoid. To prevent, if possible, any such dislodgment of the second piece of gutta percha, it was attached to the edge of the opening with a single silver clip (Fig. 1).

Course Following Second Operation.—February, 1933, to January, 1935.—The improvement which followed was again encouraging and more definite than had been expected in the face of the apparent medullary extension of the lesion. The respiratory crises, which had been so exhausting and dangerous, disappeared entirely for over one and a half years, the patient's voice returned to normal and the ptosis of both eyelids disappeared in the course of about six months. These improvements have been maintained with the exception of the attacks of respiratory embarrassment which recently have begun to recur occasionally.

Comment.—There are several somewhat unusual features in this case which deserve brief comment. The long duration of symptoms is characteristic of the slow progress of syringomyelia and might perhaps be considered as an argument against, or as a possible explanation of, the results of surgical intervention. On the other hand, it is encouraging to find that such gratifying improvement in some symptoms may result from operation in the presence even of a long standing process. This patient is one of the few in which a secondary operation has permitted an examination of a myelotomy incision some years after it was made. The finding of the closure of the original incision, as well as the prompt improvement after it was reopened, may be advanced as an argument in favor of repeated drainage in selected cases.

CASE II.—L. B., white male, aged 27 years (No. 25711), was admitted to the Neurosurgical Service of the University Hospital, December 26, 1932.

Summary.—This patient suffered from intermittent attacks of neck and shoulder pains associated with paresis at first of the left leg and then the other extremities over a period of four years before admission. The marked motor and sensory losses almost completely disappeared after drainage. His symptoms recurred in ten months and at a second laminectomy an intramedullary cyst $3\frac{1}{2}$ cm. in length was drained. His subsequent return to a nearly normal neurologic status has been maintained for one year and two months.

History.—In 1928, for about one week, the patient first suffered from nocturnal attacks of rather severe aching pains at the base of the neck which radiated over both shoulders. These disappeared spontaneously, but one year later (1929), while playing football, he developed weakness in flexion of the left upper leg. This weakness, which was at first so marked as to make climbing stairs difficult, gradually lessened in the course of six months. With the exception of a brief return of the neck and shoulder pain in December, 1930, the patient was well until October, 1931, when, following an attack of pharyngitis, he suffered first a recurrence of the cervical ache and then developed a complete paralysis of both lower extremities, marked weakness of both hands, and a numbness of the right leg. In the course of about three months, these disturbances slowly cleared up almost entirely, but similar briefer attacks of pain and marked paresis of all extremities occurred more and more frequently during the ensuing year (1932), and he entered the hospital with these symptoms in December, 1932.

Examination on First Admission.—December, 1932.—The patient was found to have a marked motor deficit, including a spastic paraplegia, weakness of flexion, and paralysis of extension in the arms (slightly more complete on the left), with atrophy of the muscles of the forearms and hands. He showed a considerable loss of sensation, pain and temperature sense was absent over C 8 and from D 4 to D 12, and diminished in both lower extremities, particularly in the right. Touch was preserved but somewhat impaired in

the same areas, and vibration sense was lost from D 4 down (Fig. 3). Hyperactive tendon reflexes were found in the lower extremities, and hypo-activity of those of the upper extremities was noted. There were bilateral Babinski and Troemner reflexes, and a bilateral ankle clonus. There were slight changes in the roentgenographic appearance of the second to fifth cervical vertebrae, inclusive. The spinal fluid contained 5.5 units of protein and the Queckenstedt test demonstrated a partial subarachnoid block.

First Operation.—January 6, 1933.—An exploratory laminectomy was performed at which the laminae and spinous processes from C 4 to C 7 were removed. At the level of the seventh cervical cord segment, there were a number of arachnoid adhesions and the spinal cord seemed twice its normal diameter and unusually soft to palpation

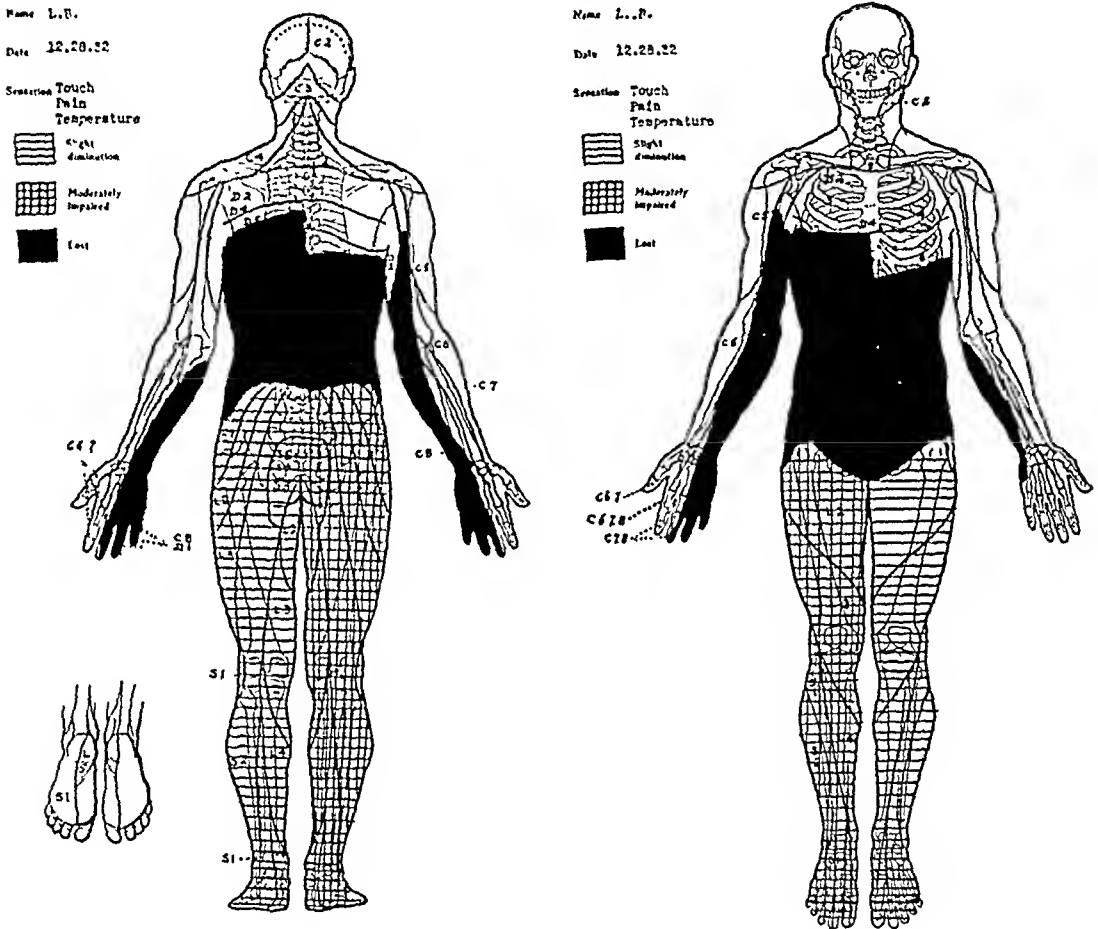


FIG. 3.—(Case II.) Pain sensation on first admission.

(Fig. 2). A hypodermic needle was introduced into the cord and a few drops of blood-tinged fluid were evacuated. When a short median incision was made at this point, a small cyst was encountered 1 Mm. below the surface. Since this cavity did not contain enough fluid to account for the enlargement of the cord, it seemed probable that the process was an intramedullary glioma rather than a syringomyelia. Accordingly, the dura mater was left unsutured and the wound closed.

Interval History.—January to October, 1933.—The surgical recovery was uneventful. Within two days of the operation the patient began to show a surprisingly rapid and extensive neurologic improvement. His sensory changes disappeared almost entirely, and the only remaining evidence of pyramidal tract damage was a left-sided ankle clonus. The improvement continued for six months, the patient being able to walk, swim and run and in general lead a very active life. However, beginning in September,

1933, there was gradual return of the old cervical pain and weakness in the left side, and the patient reentered the hospital.

Examination on Second Admission.—October 10, 1933.—The neurologic changes at this time were found to be slightly less marked than on the first admission, although there was a considerable loss of motor power in all extremities and the sensory impairment was greater than that of the earlier examination (Fig. 4). Since the Queckenstedt test again showed a partial subarachnoid block, and since there seemed some possibility of cyst formation in the lesion, operation was again advised in spite of the previous diagnosis of intramedullary glioma.

Second Operation.—October 28, 1933.—At the second laminectomy, the old wound

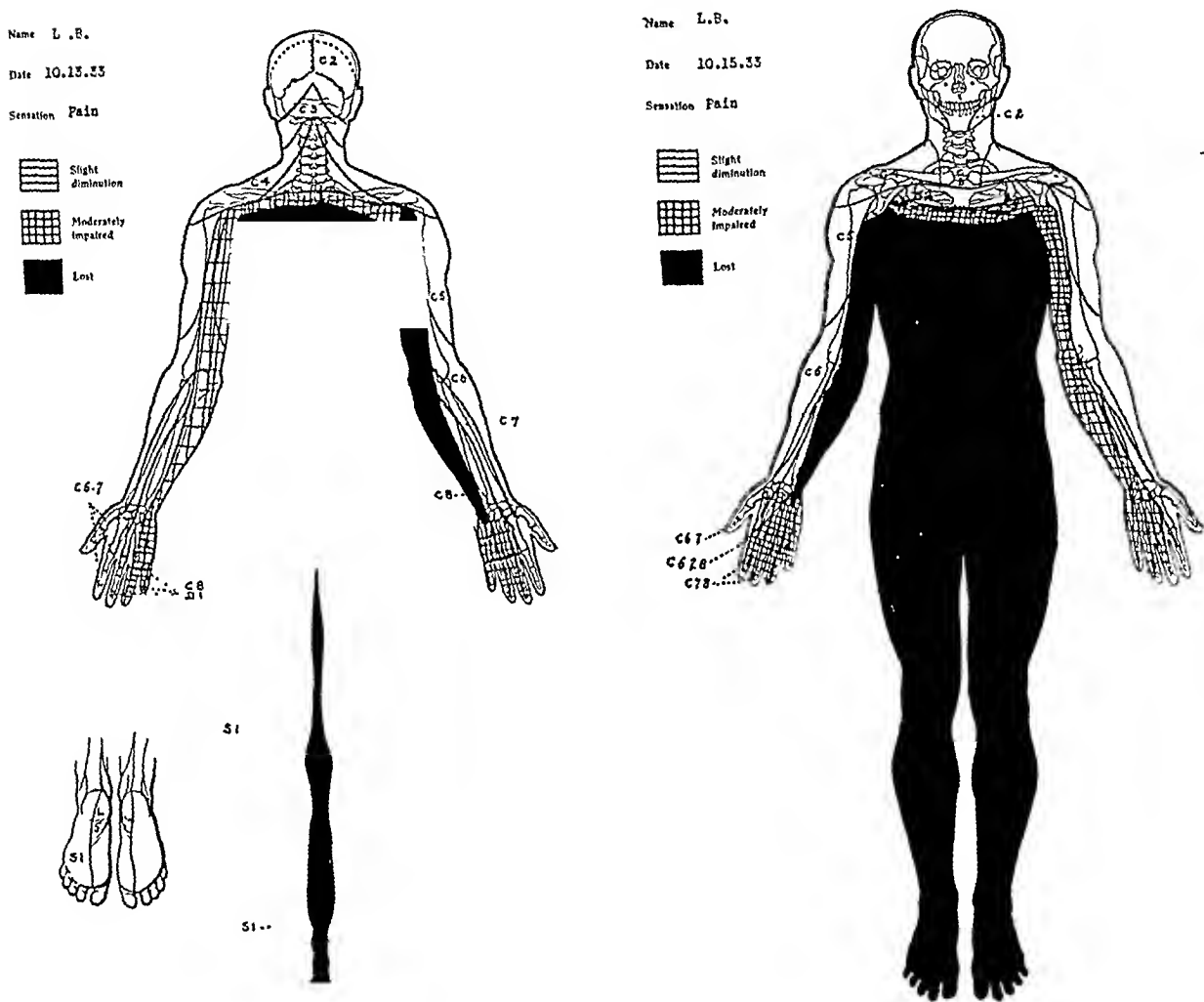


FIG. 4.—(Case II.) Pain sensation on second admission.

was reopened and additional laminae, T 1 and T 2, removed. At the level of the seventh spinal cord segment, the enlarged cord was found to be adherent to the dura mater. Through a fine needle, fluid was again evacuated from this area and a median incision was made into the intramedullary cavity. On this occasion, the cyst was found to measure $3\frac{1}{2}$ cm. in length. A small piece of gutta percha was inserted for drainage and secured to the edge of the incision with one silver clip.

Course Following Second Operation.—October, 1933, to December, 1934.—The post-operative improvement of the patient was again gratifyingly rapid and within a month he was able to return to his previous occupation. At the last examination (ten months after the second operation), the only positive neurologic findings were: (1) Slight weakness (about 10 to 20 per cent loss of power) in the legs; (2) mildly hyperactive tendon reflexes in the lower extremities, and (3) slight impairment of pain and tempera-

ture sensation in the left hand (Fig. 5). The last letter from the patient (one year and one month postoperatively) stated that he is now married, and has resumed his former calling as a physical director. Subjectively he is perfectly well.

COMMENT.—The clinical course in this case was unusually irregular. The patient suffered frequent rapidly developing attacks of pain and weakness of various extremities, with spontaneous returns to normal over periods of a few weeks or months. These marked remissions, so pronounced as to suggest multiple sclerosis, are difficult to explain on the basis of the findings at

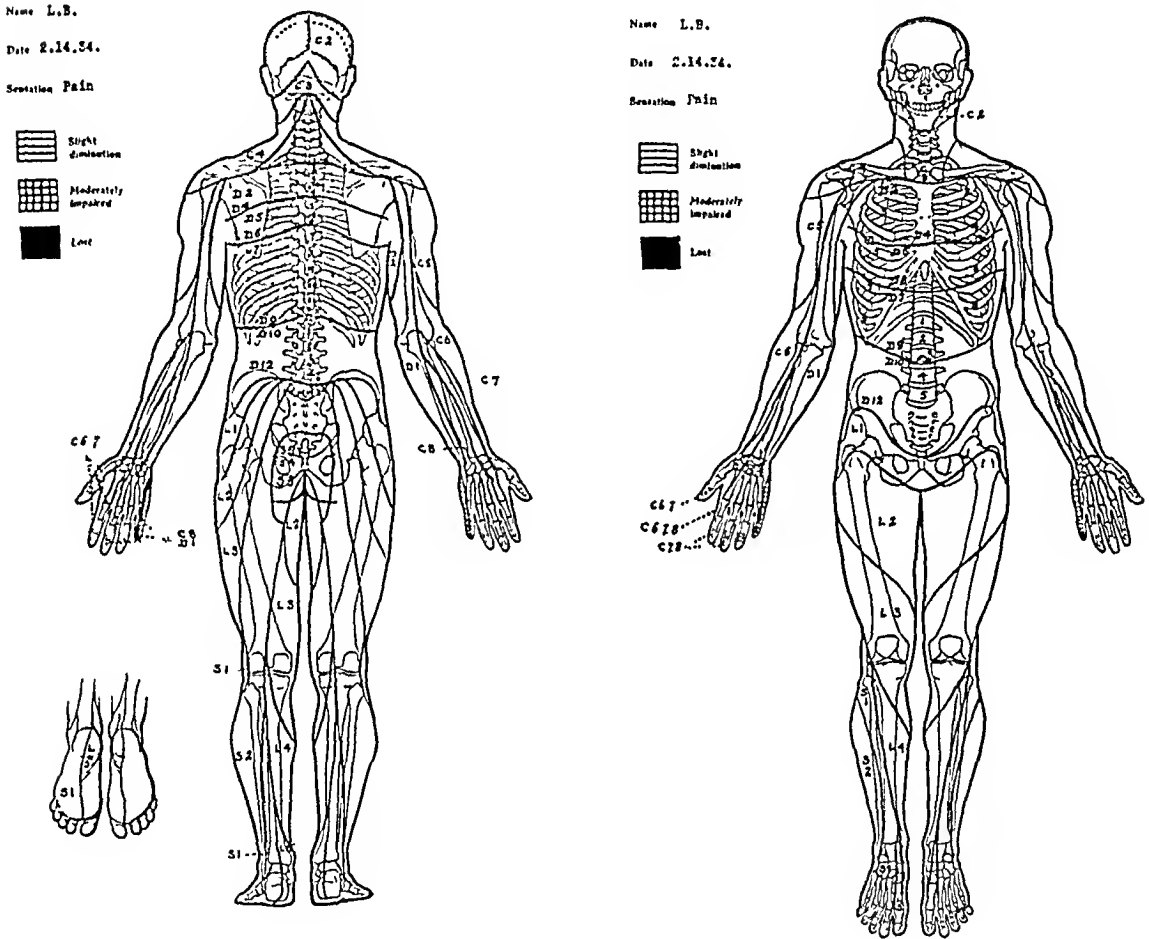


FIG. 5.—(Case II.) Pain sensation after second operation.

the first operation, unless it be assumed that pressure in the intramedullary cavity increased or that the cord became edematous at the times of the relapses.

The pathologic features of this case are of interest. From the course of the disease it seems quite certain that the lesion was syringomyelia and not, as assumed at the first operation, intramedullary glioma. Nevertheless, the evident gliosis, as seen at the first operation, leads us to postulate that this process may well be the predominant early pathologic feature in some cases of syringomyelia. These observations may be offered as evidence against the theory that the sequence of events in the progress of syringomyelia is (first) cavity formation, and (second) a reactive glial proliferation about the cavity.

Finally, the unexpectedly good results following both operations in this patient are worthy of comment. The improvement after the first laminectomy may perhaps be ascribed to the decompressive effects of leaving the dura unsutured and suggests that such a procedure may be the best method of dealing with cases of syringomyelia in this stage. But the improvement after the second intervention must be attributed to drainage of the syringomyelic cavity, and leads us to the conclusion that, even in the presence of an extensive gliosis, pressure in the intramedullary cyst may be the more important cause of loss of function.

TREATMENT.—During the past 30 years, two methods of therapeutic attack upon syringomyelia have been developed: (1) Irradiation, and (2) surgical drainage. Since Raymond,¹⁶ in 1905, described the improvement in a case treated by roentgen rays, a considerable number of workers have reported upon the use of roentgen therapy. The majority of these writers have obtained favorable results in a certain percentage of cases. The statistics presented in one of the best of the recent papers (Markow, *et al.*²), summarizing the studies of 32 patients seen during four years, are representative. In this group, eight cases showed definite improvement, seven cases remained stationary for a “long” period, and 12 for four to five months; and five progressed during the treatment. It is important to remember that irradiation is considered to affect only the gliosis, and consequently is of little value in the presence of cavitation. This may be the explanation of the rather poor results of roentgen therapy in many instances. In this clinic, for example, we have never seen more than very transitory results for the use of irradiation.

In 1916, Elsberg³ reported that several patients suffering with syringomyelia had been greatly benefited by laminectomy and incision into the syringomyelic cavity within the cord. In 1926, Puusepp⁴ reported the same operation without knowledge of Elsberg’s previous cases. Since this date, the surgical treatment of the disease has become well recognized throughout the world and nearly 100 cases have been reported.

Since the surgical attack is directed toward the syringomyelic cavity, and the roentgen ray is effective only in dealing with gliosis, it is possible that a combination of the two methods may ultimately prove to be the best method of dealing with the disease.

THE TECHNIC OF OPERATION.—The technic of the operation for syringomyelia has varied in the hands of different operators more widely than might be expected. The location of the incision, both as to level and on the circumference of the cord, the value of drainage of the cyst without laminectomy, the length of the cord incision, the means of determining the extent of the process, the material used for drainage, and the closure or nonclosure of the dura mater—all are problems of technic that ultimately may affect the results.

(1) *The Location of the Incision.*—It has been suggested (Schaeffer⁵) that the opening into the spinal cord should be at the inferior or lower end of the syringomyelic cavity to provide the best drainage. The very valid and

logical theoretical answer to this recommendation is the statement of Peiper⁶ that the opening between the syringomyelic cavity and the subarachnoid space merely brings the pressures in the two fluid filled spaces into equilibrium. From a practical standpoint, moreover, excellent results have followed drainage at the level of greatest diameter of the intramedullary cyst rather than at its most dependent level.

Whether the incision should be mesial or lateral cannot be determined preoperatively on theoretical grounds. The majority of surgeons make the incision in the midline or just to one side of the midline. Because the cystic cavity in many cases lies more anteriorly than posteriorly, Oppel¹⁵ maintained that an anterolateral incision was the safest and the most logical. His experiences with this plan were not encouraging, however, and it has not been adopted by others. Furthermore, Schmieden⁷ pointed out that in some cases (as in one of his), the anterolateral approach may be extremely difficult, if not impossible, because of the marked enlargement of the spinal cord.

(2) *Drainage of the Cavity Through a Needle*.—Drainage of a syringomyelic cavity by direct puncture without laminectomy has been advocated by Vitek^{8, 9} and others. Vitek merely reported improvement in four patients following this procedure, but further details are not available. Most writers have been either dubious or strongly opposed to this technic, although Puusepp¹⁰ and others have used it for the injection of lipiodol into the intramedullary cavity as an aid in diagnosis. In Case I of our series, an exploratory needle was used to determine whether the cyst had refilled and a second operation was justifiable. Not only did the myelo-puncture demonstrate that the cavity had refilled, but in the improvement which followed clearly justified a second operation.

(3) *The Maintenance of Drainage*.—How best to maintain drainage is still a mooted question. The available data are meager. Christophe¹¹ found his incision still patent one month after he had made an opening into a cystic glioma. Ssosson-Jaroewitsch,¹² on the other hand, found no trace of his previous operation when he performed a second laminectomy on one of his syringomyelia patients.

In both of our cases, two operations were performed. Not a trace of the first incision was found in either patient, although in Case I a gutta percha drain had been used at the first operation. There can be no doubt, therefore, that in some instances, as the result either of arachnoid adhesions or wound closure by gliosis, the operative incisions do close. Whether this is true in all or in a majority of cases cannot yet be stated. The presumption that some such healing process does occur has led to the use of various measures aimed at insuring permanent drainage. Thus, Sharpe used silk thread; Mucenicks, dura mater; Peiper, excision of a window of cord tissue; Schaeffer, muscle; Gardner, silver clips about the margin of the incision; and Frazier, gutta percha secured in place with a silver clip.

Since there has been no observation after the use of any of these (except the gutta percha in our first case) the preference for one or the other material

is still an open question. On theoretical grounds, a foreign non-absorbable material should give greater assurance against closure of the incision, though it might prove more irritating.

(4) *Exploration and Visualization of the Cavity.*—Many surgeons use a sound or ureteral catheter to explore and determine the size of the cavity. Others have decried this practice. Still others have injected a few minims of lipiodol into the cavity at the operation (or by a needle before operation) to visualize the process in the roentgenographic films. To measure the length of the cavity we prefer a ureteral catheter; it is easy of manipulation and non-traumatizing; thus the irritating effect of lipiodol is avoided. As Juzelevsky¹³ has pointed out, the danger of damaging the spinal cord by sounding the cavity is minimized because of its glial wall.

(5) *Closure of the Dura Mater.*—If the drainage incision remains patent, there seems to be no need for the decompressive effect obtained by leaving the dura mater unsutured. If the incision into the cavity closes, the subsequent expansion of the cord will cause compression eventually, even though the dura is not sutured. Consequently, there seems to be no reason for this measure unless the lesion is one chiefly of gliosis with little or no cavity formation, as was the situation in our second case.

(6) *Repeated Operations.*—From the data available at present, it is certain that some of the failures of operation for syringomyelia are the result of closure of the artificial communication established between the intramedullary cavity and the subarachnoid space. When this occurs, a second operation seems more than justified. If the decision is difficult (Case I) a trial of the effects of drainage by needle should determine the issue. The patient may fail to improve after the first operation but gain rapidly after the drainage of a second cyst. Mucenicks¹⁴ and Oppel¹⁵ have both reported this experience. In general, then, it may be concluded that in many cases with improvement following operation and subsequent relapse the patient may obtain great benefit from a second intervention.

THE LATE RESULTS OF OPERATION.—The results of surgery in 16 cases of syringomyelia in which an observation one year or more postoperatively was reported is presented in Table I, and summarized in Table III.

An analysis of the late results of surgery in the treatment of syringomyelia is difficult not only because of the variability and complexity of the cases, but because of the lack of detail in a number of the available reports. Nevertheless, as is shown in Table I, some grouping of the cases on the basis of results is possible. Group I, Table I, comprising those patients in whom the least improvement occurred following operation, includes three cases. Two of these patients (Nos. 1 and 2, Table I) were unchanged after operation, although it is to be noted that one of them was thought to have been benefited to the extent that a rapid downhill course was arrested for at least one year. One additional patient (No. 3), while profiting greatly from the return of sphincter control and the relief of pain and bulbar symptoms, showed relatively little improvement in motor or sensory function. At the other extreme, are the results in

TABLE I

Case No.	Operator (Author)	Date Oper-ated On	Sex and Age	Size of Cavity	Site of Incision	Drain Used	Follow Up. Years	Remarks		Group Result
								Late Result	2 swellings	
Group I										
1	Putnam and Munro	1926	M. 55	?	Midline	None	1.5	No change	2 swellings	Very little change
2	Kirschner (Ellmer)	1930	M. 25	?	Midline	Muscle	1	No change	Rapidly progressive	
3	Frazier-Rowe (1) (2)	1930 1933	F. 35	?	Right dorsolateral Same	Gutta-percha Same	4.5 2	Relieved incontinence and bulbar symptoms	Bulbar symptoms beginning to recur	
4	Elsberg Case 1	1914?	"Sever-eral"		Dorsolateral	None	2?	Improved		Moderate im-provement
5	Sharpe	1917	M.	5 cm.	Midline	Linen thread	2	Walked. Arms improved	Stationary in 1 year	
6	Puusepp Case 2	1926	M. 25		Dorsolateral	None	7	Improved		
7	Muenicks (1) (2)	1931 1931	F. 40	4 cm. 5 cm.	Midline cervical Midline lumbar	Dura mater	1.5 1.2	Improved after second operation		
8	Schmieden	1929	F. 30	16 cm.	Left dorsolateral	None	2.5	Improved	Last seen by Peiper	
9	Elsberg Case 2	1914	M.		Dorsolateral	None	2?	Returned to work	Occupation, tailor	Marked im-provement; returned to former occu-pation
10	Puusepp Case 1	1926	M. 23	3 cm.	Dorsolateral	None	7	Walks normally Hands improved	Slight sensory loss	
11	Puusepp Case 3	1927	M. 60	22 cm.	Dorsolateral	None	2	Returned to work		
12	Puusepp Case 4	1927	M. 23	8 cm.	Midline?	None	7	Returned to work	Occupation, farmer	
13	Puusepp Case 5	1927	M. 37	17 cm.	Dorsolateral	None	4	Almost normal	Slight sensory loss	
14	Foerster	1929	M.		Dorsolateral	None	2	Almost normal	Hydroinycelia?	
15	Heymann	1923	M.		"Posterior"	None	7	Able to work	Secretary	
16	Frazier-Rowe (1) (2)	1933 1933	M. 27	3.5 cm.	Midline Midline	None Gutta percha	2 1	Improved 6-7 mos. Almost normal	Athletic teacher	
Group III										

seven patients (Group III, Table I, Nos. 9 to 16, inclusive) who were able to return to their occupations after operation, three of them (Nos. 13, 14 and 16) being almost entirely well. The remaining six cases (Group II, Table I, Nos. 4 to 8, inclusive) fall into an intermediate group characterized by varying but incomplete degrees of recovery.

Do these results justify surgical drainage in the treatment of syringomyelia? That in 50 per cent of this series the improvement was sufficient to permit the patient to work, an improvement maintained from one to seven years, seems to us to more than counterbalance the possible dangers or possible failures of operation. It is of interest to note, too, that among the failures of this series no patient was the worse for the surgical undertaking.

It has been suggested that the results of the surgical treatment of syringomyelia bear some relation to the duration and the extent of the lesion. In reviewing the late results, we will attempt to determine the relative importance of these and such other factors as are believed to influence the clinical course after operation. Of these factors, presumably the most important are: (1) The sex and age of the patient; (2) the duration of symptoms; (3) the extent of the disease process; and (4) the operative technic employed. It may be that in any one case the result depends upon a combination of these factors. But, in addition, one must take into consideration unknown variations in the pathologic process.

In the 16 cases included in our analysis, the sex and age seem unimportant. It so happens that most of the patients were males. The range of known ages was 25 to 55 in Group I, 23 to 40 in Group II, and 27 to 60 in Group III.

The preoperative duration of symptoms in these three groups is shown in Table II. While indicating that, in general, poorer results are to be expected from operations on patients who have had symptoms more than seven years, the analysis of the cases in Table II is surprising in two respects: first, because excellent results were obtained in patients with an average duration of symptoms of over five years, and secondly, because one of these had had symptoms for 13 years.

TABLE II
PREOPERATIVE DURATION OF SYMPTOMS

Group	Number of Cases	Results	Shortest Duration	Longest Duration	Average Duration
I.....	3	Poorest	1.5 yrs.	15 yrs.	7 yrs.
II.....	6	Intermediate	.66 yrs.	13 yrs.	3.9 yrs.
III.....	7	Best	.66 yrs.	13 yrs.	4.9 yrs.

The third factor, which might influence the postoperative course, is the extent of the process as indicated by the clinical picture and by the character of the lesion as seen at operation. In Group I, the clinical pictures vary from moderate to very severe, and the processes, as viewed and described by the surgeon, similarly were variable. In these cases, the exact size of the cavities is not known, but presumably in most cases the cavities were larger. On the

TABLE III
SUMMARY OF SIXTEEN CASES WITH POSTOPERATIVE PERIODS OF OBSERVATION OF ONE YEAR OR MORE

Case No.	Operator (Author)	Date Operated On	Sex and Age	Motor Symptoms	Sensory Symptoms	Atrophy	Size of Cavity	Site of Incision	Drain Used	Follow Up. Years	Late Result	Remarks	Group Result
1	Putnam and Munro	1926	5	M. 55	Paresis of left arm	All forms impaired T 1 down	Left arm	Midline	None	1 5	No change	2 swellings	
2	Kirschner (Ellner)	1929	1 5	M. 25	Paresis both hands, Left worse	Impaired pain and touch in hands	Hands	Midline	Muscle	1	No change	Rapidly progressive	Very little change
3	Frazier-Rowe (1)	1930	15	F. 35	Paralysis left arm Paresis legs, right arm Quadriplegia	Loss C 2 down and impaired pain in face	All extremities Worse left	Right dorsolateral	Gutta-percha	4 5	Relieved incontinence and bulbar symptoms	Bulbar symptoms beginning to recur	
	Case 1 (2)	1933			Same as above	Worse		Same	Same	2			
4	Elsberg Case 1	1914?	"Surgical"					Dorsolateral	None	2?	Improved		
5	Sharpe	1917		M.	Spastic paraplegia. Flac. paral. arms	"Dissociated sensory disturbance"	5 cm.	Midline	Linen thread	2	Walked. Arms improved	Stationary in 1 year	
6	Puusepp Case 2	1926	3	M. 25	Paresis hands Slight paresis legs	Loss pain and touch C 5 to T 6	Arms	Dorsolateral	None	7	Improved		Moderate improvement
7	Mueeniks (1)	1931	.6	F. 40	Paresis legs and left arm	Slight impairment pain and touch, legs	4 cm.	Midline cervical	Dura mater	1 5	Improved after second operation		
	(2)	1931			Same	Same	5 cm.	Midline lumbar		1.2			
8	Schmieden	1929	13	F. 30	Paresis left arm and leg Slight paresis right arm	Impaired pain right half body	16 cm.	Left dorsolateral	None	2.5	Improved	Last seen by Peiper	

Group I

Group II

TREATMENT OF SYRINGOMYELIA

9	Elsberg Case 2	1914? "Sev- eral"	M.	Dorsolateral			Nonc	2?	Returned to work	Occupa- tion, tailor			
10	Puusepp Case 1	1926	1	M. 23	Paresis left hand Slight paresis right hand	Loss pain over neck, arms	Hands	3 cm.	Dorsolateral	None	7	Walk nor- mally. Hands improved	Slight sensory loss
11	Puusepp Case 3	1927	5	M. 60	Paresis right arm and leg	Loss pain over right half body, face	Right extremi- ties	22 cm.	Dorsolateral	None	2	Returned to work	
12	Puusepp Case 4	1927	4	M. 23	Paresis arms, hands and slight legs	Pain impaired in upper ex- tremities	Upper extremi- ties	8 cm.	Midline?	None	7	Returned to work	Occupa- tion, farmer
13	Puusepp Case 5	1927	.66	M. 37	Spastic para- plegia Paresis right arm	Loss pain over right 1/2 body and face	Right arm	17 cm.	Dorsolateral	None	4	Almost normal	Slight sensory loss
14	Foerster	1927		M.	Paresis both arms and both legs	Disturbance sensory C 1- T 3 and left face	Atrophy arms		Dorsolateral	None	2	Almost normal	Hydro- myelia?
15	Heyman	1923	13	M.					"Posterior"	None	7	Able to work	Secretary
16	Frazier- Rowe (1)	1933	4	M. 27	Spastic para- plegia Paresis both arms	Loss pain C 8, D 4-D 12, and legs and hands	Forcarms		Midline	None	2	Improved 6-7 mos.	
	Case 2 (2)	1933			Same	Nearly same	Arms	3.5 cm.	Midline	Gutta percha	1.1	Almost normal	Athletic coach

Marked
improve-
ment; re-
turned to
occupa-
tion

Group III

other hand, among the patients with the best results (Group III) the clinical pictures again varied from moderate to very severe, with cyst cavities which were known to range from 4 to 16 cm. in length. It is plain that in this series, at least, the late results do not show as close a correlation with the preoperative extent of the process as might be expected. It is possible, of course, that the discrepancy will become less marked in the future with the addition of more cases and improvement and standardization of operative methods.

The remaining important source of variation in the results is the operative technic. Suffice it to say here that since the correlation between other variable factors in each case and the extent of the postoperative improvement of the patient is so uncertain, it would seem reasonable to regard the surgical technic employed as highly important.

It is evident, then, that the factors controlling the results are not entirely understood, and probably are pathologic as well as clinical. It does seem possible that the operative technic may be important, but age, duration and the extent of the disease do not at present seem closely related to the ultimate improvement. The careful observation of the extent and character of the pathology at operation as well as at autopsy in more cases will doubtless lead to a clearer solution of these problems. At present, in spite of the difficulties of predicting the exact results of operation preoperatively, two facts seem certain: (1) The majority of the reported operated patients who have been followed for more than one year have been benefited, and (2) none of this group has been made worse by the surgical intervention.

SUMMARY

(1) Two cases of syringomyelia are recorded in which surgical treatment resulted in improvement over periods of four and one-half and two years, respectively.

(2) Fourteen additional cases from other clinics, whose period of post-operative observation was one year or more, have been analyzed. A review of the results in 16 cases shows that half of them (eight patients) were sufficiently improved to return to their former occupations.

(3) Sex, age, the extent of the process or the preoperative clinical picture seemed to have little bearing upon the operative results. Probably the duration of the disease and the technic employed, to a certain extent, may influence the end-results.

(4) A judicial review of the various technics employed suggests that: (a) A vertical cordotomy in the midline posteriorly or a few Mm. lateral to it on the side of the greatest cord damage (as evidenced by the clinical picture) is the most efficacious and the least dangerous approach to the syringomyelic cavity. (b) An attempt at establishing permanent drainage by the use of drainage material seems worth while. (c) If, after the initial drainage, the clinical course suggests a closure of the incision into the syringomyelic cavity, a second operation is indicated.

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DISCUSSION.—DR. WILLIAM JASON MIXTER (Boston, Mass.): I am very much interested in syringomyelia and feel that our experience in Boston has been similar to that of Doctor Frazier in many ways. We have also been discouraged with the result of simple incision of these cystic cavities, and have wondered whether some means of permanent drainage might be carried out. Some patients improve under roentgen ray therapy but it is difficult to measure the extent of improvement and unsatisfactory because any improvement gained is frequently temporary. Eighteen cases have been operated upon since 1919 by opening the cavity, and one of them at least had repeated operations of that sort. Some of these patients who have been operated upon have gone back to work for a short time, but all have had a recurrence of symptoms.

During the last eight months, I have operated upon two cases, using a slightly different method from that which Doctor Frazier has suggested. In these two cases, the cavity was opened longitudinally and the lining membrane of the cavity was sutured to the arachnoid at each side, thus forming a lozenge shaped opening which I hope will remain permanent, though I have no proof that such will be the case. Both of these patients have improved markedly and have gone back to work, though one of them is still greatly handicapped. Neither of them has been of sufficiently long duration to give us any idea as to the permanency of the result.

COMPLETE SYMPATHECTOMY

OBSERVATIONS OF CERTAIN VASCULAR REACTIONS DURING AND AFTER COMPLETE EXCLUSION OF THE SYMPATHETIC NERVOUS SYSTEM IN DOGS *

AN EXPERIMENTAL STUDY

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CANNON and his coworkers¹ showed that animals subjected to complete extirpation of both sympathetic nerve chains could live indefinitely under controlled laboratory conditions, but thought that such animals were unable to cope normally with changes in their environment. Subsequently, other workers,^{2, 3} have used Cannon's technic to study the physiology of the sympathetics, and Bradford Cannon¹ has described observations on the blood pressure changes resulting from the various stages of complete sympathectomy.

The present experiments were undertaken in an effort to investigate further the relationship of the sympathetic nervous system to the blood pressure. It was especially desired to study the factors concerned in the causation of lowered blood pressures in relation to traumatic shock. Roome, Keith, and Phemister⁵ described experiments in which the blood pressure was reduced by various methods, and the circulating blood volume estimated by bleeding; certain similar studies will be described on completely sympathectomized animals.

EXPERIMENTAL METHODS

Method of Preparation of Animals.—Dogs were used in all experiments. Complete extirpation of the sympathetic chains was carried out in three stages, from 10 to 21 days intervening between operations. All operations were under ether anesthesia, with positive pressure when the chest was to be opened.

The right thoracic sympathetic chain was first removed from above the stellate ganglion to the diaphragm; secondly, the left thoracic chain was similarly removed; and lastly, both abdominal chains were excised from the diaphragm to a point in the pelvis 1 to 2 cm. below the sacral promontory. The completeness of the sympathectomy was checked in each animal at the time it was sacrificed by careful search for remaining portions of the chain. In two dogs a single ganglion was found at the diaphragm on the left side; the left splanchnic, however, was found sectioned in every dog. Although technical difficulties prevented removal of the lower sacral sympathetic chains, these remaining ganglia receive their preganglionic fibers from or through proximal ganglia surgically removed and were thus separated

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from the central nervous system. The term "complete sympathectomy" refers in this paper to this complete isolation of the peripheral sympathetic nerves from the central nervous system.

EXPERIMENTS

I. The Blood Pressure Changes During and After Progressive Sympathectomy

In 1931 Cannon⁴ described the blood pressure changes occurring after the various stages of total sympathectomy in dogs. The order in which Cannon removed the various segments of the system differs from that of the present experiments; he first removed both abdominal chains, then the right thoracic, and lastly the left thoracic. The blood pressure in his experiments was measured indirectly, and was found to fall immediately after each operation. Following this depression, there was after the first two stages a marked rise of the pressure above the control level, which persisted over a period of several days and then gradually tended to return to the control level. After the final operation the blood pressure fell lower than at any time previously and then rose to nearly the control level.

In the present experiments the blood pressure was recorded on a kymograph by the direct method of arterial puncture with a 20 gauge needle, connected to a mercury manometer.

A. Control Experiments.—(a) Four dogs were merely kept caged in the laboratory for three months, and the blood pressure recorded as described every three to ten days. The maximum range of variation observed during this period was 25 Mm./Hg. and the maximum depression from the original readings at the end of the period was 10 Mm./Hg.

(b) Two dogs were subjected to dummy operations similar to the three stages of complete sympathectomy. These operations consisted of: (1) opening the right pleural cavity, and scarifying the pleura parallel to the entire right thoracic chain; (2) after an interval of 10 to 14 days, a similar procedure in the left chest, and (3) finally a laparotomy, with considerable exploration and manipulation. The blood pressure was recorded as described, and in both dogs was found to remain within 15 Mm./Hg. of the initial readings.

B. Experiments During and After Sympathectomy.—In 13 dogs the blood pressure was recorded at frequent intervals during the course of complete sympathectomy and for 9 to 27 days after the final stage.

There was observed a sharp depression of the blood pressure of from 15 to 50 Mm./Hg. on the day following each operation, the least fall usually occurring after the third stage and the greatest fall after removal of the left thoracic chain (second stage), at which time the left splanchnic nerve was sectioned at the diaphragm. After the first operation the pressure returned to the control level or slightly above in six dogs (the maximum rise above the control level being 15 Mm./Hg.) within a week, while in the remaining seven dogs the blood pressure was still 15 to 25 Mm./Hg. below the control level at the end of two to three weeks.

One week after the final operation the average of the blood pressures was 36 Mm./Hg. below the control level, and two to three weeks after the final stage the average was 30 Mm./Hg. below the normal average (Table I). Three typical blood pressure curves during progressive sympathectomy and one dummy curve are given in Charts 1 and 2. It was found that the blood pressure gradually returned to normal

over a period of months; further observations on this subject are to be published in a later paper (Grimson).

TABLE I

THE BLOOD PRESSURE OF COMPLETELY SYMPATHECTOMIZED DOGS

Dog No.	Initial blood pressure, Mm./Hg.	Blood pressure one week after final stage of sympathectomy, Mm./Hg.	Blood pressure two to three weeks after final stage of sympathectomy, Mm./Hg.
241.....	128	112	120
290.....	156	107	101
293.....	160	120	123
294.....	127	102	100
308.....	143	113	135
356.....	145	118	104
374.....	126	112	110
406.....	145	106	106
407.....	130	84	...
408.....	163	115	122
470.....	140	100	110
507.....	165	108	116
654.....	130	90	108
Average of 13 dogs...	143	106.7	113

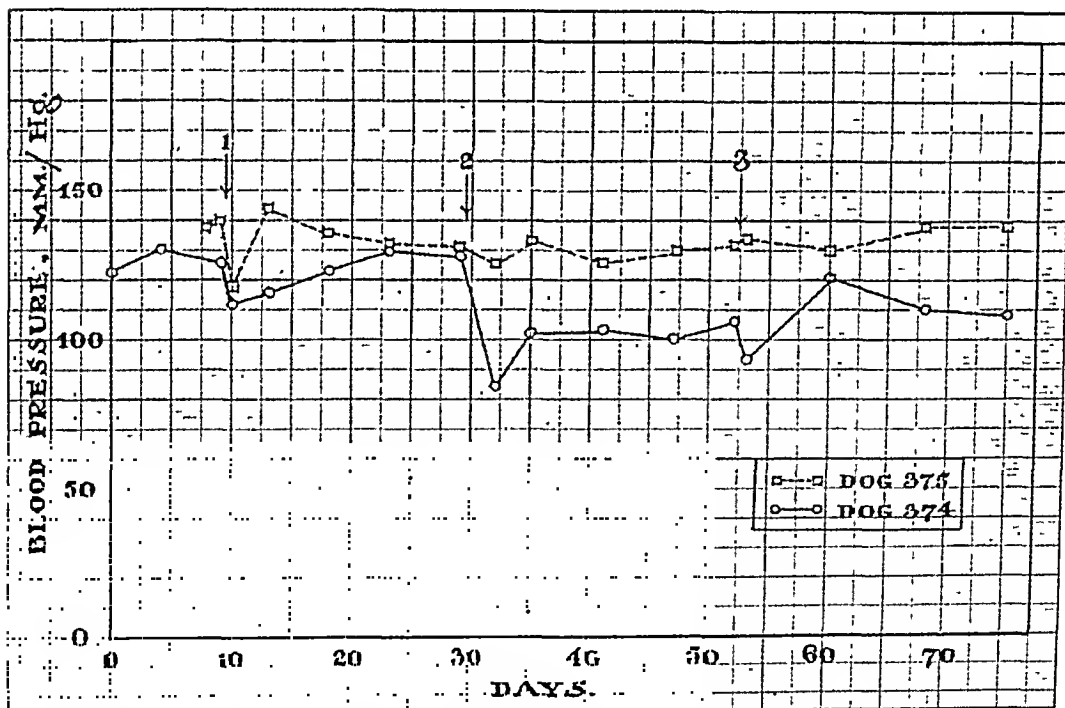


CHART 1.—Blood pressure changes resulting from three stages of complete sympathectomy (dog 374) compared with the effects of three dummy operations (dog 375) at similar intervals. The numerals 1, 2 and 3 indicate the day of the operation.

II. Effects of High Spinal Anesthesia on the Blood Pressure

It is well known that high spinal anesthesia results in a considerable fall in blood pressure, presumably by interference with conduction of vasoconstrictor impulses in the efferent spinal nerves in the dorsal region.

A. Control Experiments.—In six dogs sufficient novocain solution was injected intrathecally at the level of the second lumbar interspace to produce anesthesia usually to cervical segment levels. The mean blood pressure was recorded by a carotid

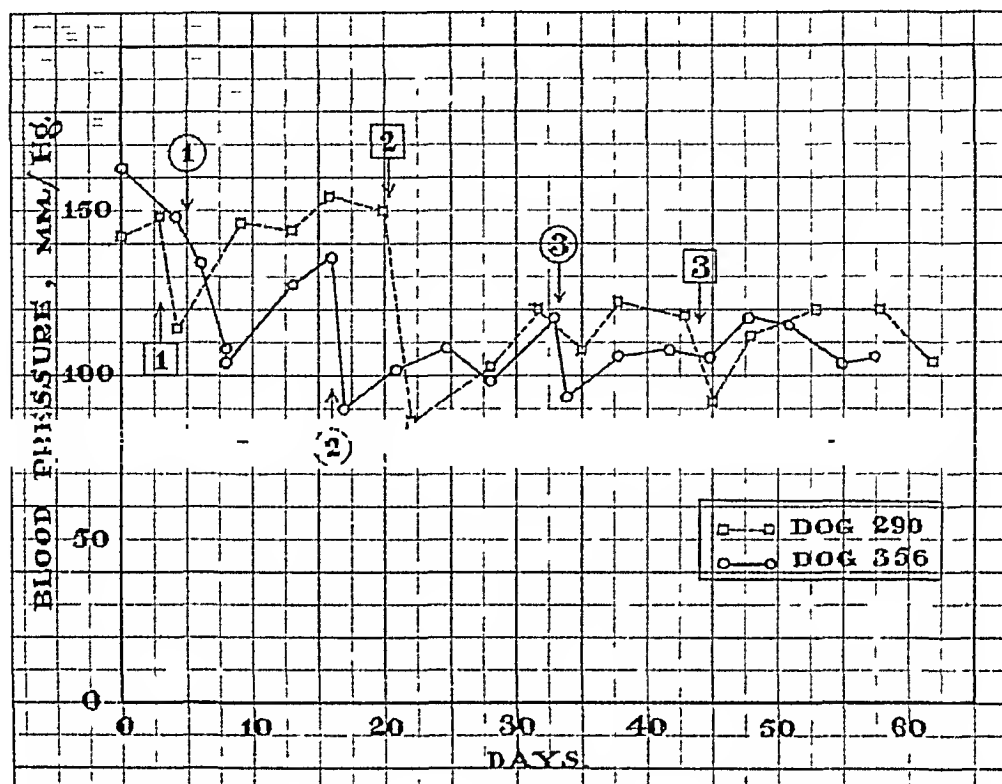


CHART 2—Blood pressure changes resulting from complete sympathectomy in two dogs
The numerals indicate the day of operation.

cannula, mercury manometer and kymograph. In every instance a marked fall of the blood pressure occurred as the anesthesia extended upward. In one experiment respiratory failure occurred and mechanical artificial respiration was used. The control blood pressures ranged from 120 to 170 Mm/Hg.; after periods of from 45 to 91

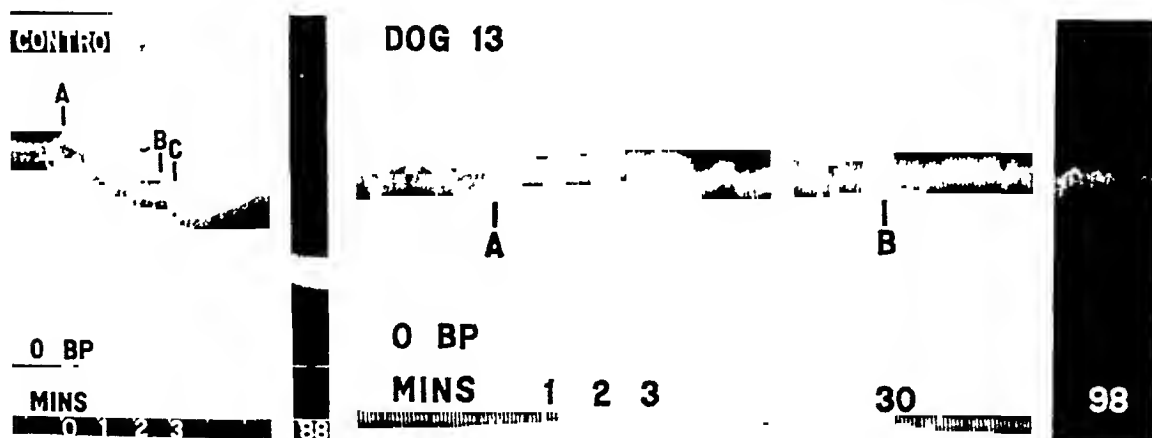


CHART 3—Typical kymograph tracings of the effect on the blood pressure of high spinal anesthesia in a control dog and in a completely sympathectomized animal (dog 13). Novocain was injected intrathecally at points A and B in both tracings and the ether anesthesia was stopped at C on the control tracing.

minutes, the blood pressures were from 48 to 70 Mm/Hg. Depressions of from 58 to 120 Mm/Hg. had thus occurred as a result of the high spinal anesthesia.

B. Spinal Anesthesia in Completely Sympathectomized Dogs.—Four experiments were carried out in the same manner as described above, upon dogs from 13 to 32 days after complete sympathectomy. In one experiment both vagus nerves were sec-

tioned before giving the spinal anesthetic. In another case, mechanical artificial respiration was necessary for imminent respiratory failure. There was no marked fall of the blood pressure in any experiment during the period of observation, 45 to 98 minutes; the blood pressure rose 2 Mm./Hg. in one animal and fell from 5 to 20 Mm./Hg. in the remaining three dogs. The results of this series of experiments and of the control series are given in detail in Table II. A typical kymograph tracing of the blood pressure response as compared with the response in the normal animal is given in Chart 3.

TABLE II

EFFECTS OF HIGH SPINAL ANESTHESIA UPON THE BLOOD PRESSURE

Dog No.	Time of experiment, days after final stage of sympathectomy	Initial blood pressure, Mm./Hg.	Duration of experiment, mins.	Final blood pressure, Mm./Hg.	Blood pressure change, Mm./Hg.
<i>(A) Control Series, Normal Dogs</i>					
305.....		170	50	50	minus 120
312.....		155	55	58	minus 97
313.....		138	45	48	minus 90
347.....		120	70	62	minus 58
385*.....		140	56	55	minus 85
417.....		154	91	70	minus 84
Average of six control dogs.....		146		57	minus 89
<i>(B) Completely Sympathectomized Dogs</i>					
136.....	13	120	45	100	minus 20
137.....	15	88	60	83	minus 5
13†.....	27	98	98	100	plus 2
27*.....	32	130	60	112	minus 18
Average of four sympathectomized dogs.....		109		99	minus 10

* Mechanical artificial respiration used.

† Vagi sectioned before spinal anesthesia induced.

III. Effects of Section of the Cervical Spinal Cord on the Blood Pressure

A profound blood pressure fall results in normal animals when the spinal cord is sectioned at high levels. This effect may be due, as in spinal anesthesia, to the withdrawal of tonic vasoconstrictor impulses, passing down from the higher centers.

A. Control Experiments.—The spinal cord was sectioned under ether anesthesia in 24 normal dogs at the level of the seventh cervical or first thoracic vertebrae. In all cases a marked blood pressure fall occurred; the initial pressures varied from 70 to 158 Mm./Hg., and fell to levels of from 38 to 90 Mm./Hg. 11 to 74 minutes after division of the cord. In 12 of the 24 animals there was a marked but transient rise of the blood pressure immediately after cutting the cord, with its maximum 15 seconds to three minutes after section. This rise persisted two to three minutes, and was followed by a gradual decline of the blood pressure. The transient increase of the blood pressure

COMPLETE SYMPATHECTOMY

was thought due to vasoconstrictor stimulation by the cutting. Six examples of typical experiments from this series are given in summary in Section A, Table III.

TABLE III
 EFFECTS OF SPINAL CORD SECTION UPON THE BLOOD PRESSURE

Dog No.	Time of experiment, days after final stage of sympathectomy	Initial blood pressure, Mm./Hg.	Time of maximum blood pressure, secs.	Maximum blood pressure, Mm./Hg.	Final blood pressure, Mm./Hg.	Time of final blood pressure, mins.	Change in blood pressure, Mm./Hg
(A) Control Experiments, Normal Dogs							
341.....		110		No rise	65	60	minus 45
420.....		117		No rise	46	65	minus 75
425.....		90	60	152	60	74	minus 30
436.....		149	15	233	90	47	minus 59
442.....		112	60	183	52	41	minus 60
443.....		138		No rise	63	40	minus 75
Average of six control dogs.....		119			62.7		minus 57
(B) Completely Sympathectomized Animals							
136.....	15	80		No rise	80	58	0
471.....		93		No rise	77		minus 16
137.....	21	90		No rise	90	60	0
117.....	50	82		No rise	80	60	minus 2
Average of four sympathectomized dogs.....		86			82		minus 4.5

B. Spinal Cord Section in Completely Sympathectomized Dogs.—The spinal cord was similarly cut in four completely sympathectomized dogs. In each case there was a slight depression of the blood pressure at the moment of section, but within two minutes it had returned to the former level, and with one exception remained at this

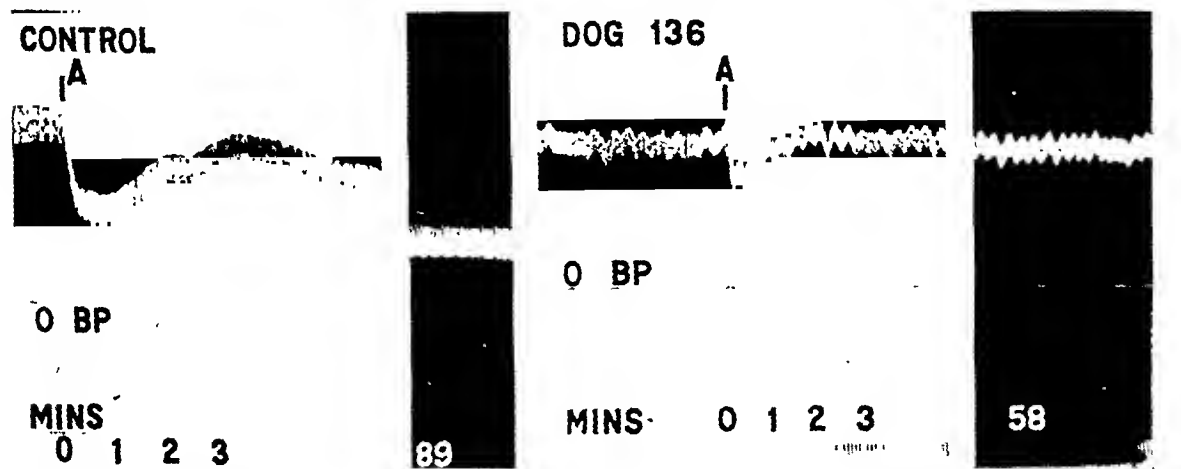


CHART 4.—Typical kymograph tracings of the effect on the blood pressure of cervical spinal cord section in a control dog and in a completely sympathectomized animal (dog 136). The spinal cord was sectioned at A. Note that the initial blood pressure of the sympathectomized animal is lower than that of the control, but the terminal blood pressure of the control dog is much lower than that of the sympathectomized animal.

level during the period of observation, from 45 to 60 minutes. In no case was there the temporary rise above the normal, as observed in half the control animals (Section B, Table III). Kymograph tracings of typical reactions in control dogs and sympathectomized dogs are given in Chart 4.

IV. Effects of Sciatic Nerve Stimulation upon the Blood Pressure

Electrical stimulation of the central end of the cut sciatic nerve results (in anesthetized dogs) in blood pressure changes which depend on the strength and frequency of the stimulus.⁶ Strong faradic currents result in a rise of the blood pressure; weaker, and slowly interrupted shocks produce a fall.

A. Stimulation with Tetanizing Current.—In six dogs completely sympathectomized for 17 to 28 days the sciatic nerve was cut and its central end stimulated with 12 different strengths of tetanizing current from a Harvard inductorium, by means of a bipolar electrode. In no case was there a definite rise of the blood pressure; with the stronger stimuli there was marked hyperventilation, and this was occasionally accompanied by a slight fall of the blood pressure, probably due to acapnia. Control animals uniformly gave the pressor response with similar stimulation. Kymograph tracings of control and sympathectomized dogs are given in Chart 5. In other experiments, to be reported later, rises in blood pressure were observed in dogs sympathectomized for longer periods.

FIG. 5.

FIG. 6.

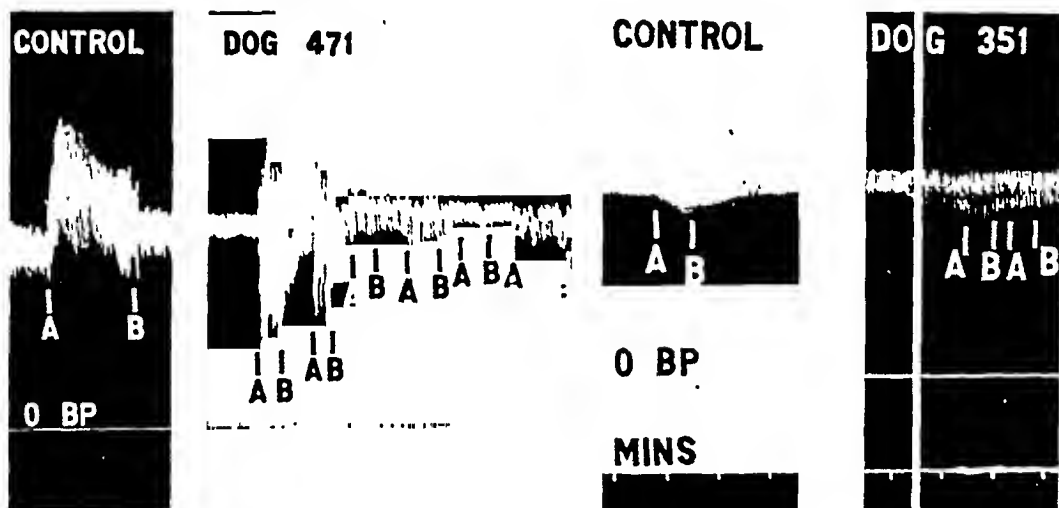


CHART 5.—Typical kymograph tracing showing the effect of stimulation of the central end of the cut sciatic nerve with various strengths of tetanizing current in a control dog and in a completely sympathectomized dog (dog 471). The stimulation was started at A and stopped at B in each case.

CHART 6.—Kymograph tracing showing the effect of stimulation of the central end of the cut sciatic nerve with slow make and break shocks, in a control dog and in a completely sympathectomized dog (dog 351). Stimulation was started at A and stopped at B in each case.

B. Stimulation by Weaker, Slower Shocks.—In four of the above animals the central end of the cut nerve was stimulated by weak make and break shocks of a frequency of about five per second. No depressor response was obtained. Four control animals uniformly responded to similar stimulation by a depression of the blood pressure (Chart 6).

V. Studies on the Bleeding Volume at "Normal" Blood Pressures

The bleeding volume has been used as an index of the circulating blood volume by various investigators.^{6, 7}

A. Control Experiments.—Roome, Keith and Phemister⁵ measured the bleeding volumes of a series of 20 normal dogs, under ether and under barbital anesthesia, in the following manner. The animal was bled to death in the horizontal position from a large cannula in a carotid artery which was kept free from obstructions; the amount bled

was described as a percentage of the blood volume calculated as 1/13 of the body weight. The average "bleeding volume" was found to be 58.6 per cent of the calculated blood volume (c.b.v.).

B. Bleeding Volumes of Completely Sympathectomized Dogs.—In five completely sympathectomized dogs the bleeding volume was measured as described, except that local anesthesia was used. The amounts obtained were from 39 to 55 per cent of the c.b.v., and averaged 49.4 per cent. This average is somewhat below the normal average, although the individual bleeding volumes fall within the normal range of variation. It must be noted, however, that the blood pressures of the sympathectomized dogs were in most cases subnormal (Table IV) and this factor must be considered in the interpretation of the results.

TABLE IV
BLEEDING VOLUMES OF COMPLETELY SYMPATHECTOMIZED DOGS

Dog No.	Time of experiment, days after final stage of sympathectomy	Blood pressure just before bleeding, Mm./Hg.	Amount bled, per cent of calculated blood volume
407.....	9	84	53.0
224.....	19	...	39.0
242.....	22	120	50.3
168.....	28	...	53.6
241.....	30	104	55.0
114.....	39	98	45.4
Average of six sym- patectomized dogs...		101.5	49.4
Average of 20 normal dogs (Roome, Keith and Phemister ⁵)....		...	58.6

VI. Studies on the Bleeding Volume at Reduced Blood Pressures

A. Control Experiments.—The bleeding volumes of dogs after reduction of the blood pressure by various methods was studied by Roome, Keith and Phemister,⁵ and these observations were used as controls for the present experiments. These authors found that the average bleeding volume of six dogs whose blood pressures were lowered to an average level of 54 Mm./Hg. by histamine administration was 50.5 per cent of the c.b.v., and that the average bleeding volume of seven dogs after graded hemorrhage, at average terminal blood pressures of 61 Mm./Hg., was 24.9 per cent of the c.b.v.

B. Experiments on Sympathectomized Animals.—Similar bleeding volume measurements were made on six completely sympathectomized dogs 19 to 41 days after the final stage of preparation. These experiments are summarized in Table V.

Three dogs were given an aqueous solution of histamine in repeated small subcutaneous and intramuscular injections in sufficient amounts to maintain the blood pressure at levels of from 40 to 70 Mm./Hg. over a period of from 45 to 50 minutes. The amounts bled at the end of this period were from 42 to 53 per cent of the c.b.v., and averaged 48.1 per cent of the c.b.v., a figure not significantly lower than the average of the control series (50.5 per cent) (Table V, Section I).

Three other completely sympathectomized dogs were gradually bled small amounts from a carotid artery, until the blood pressure remained at levels of from 55 to 70 Mm./Hg. The bleeding volumes of these animals 55 to 78 minutes after the beginning of the

TABLE V

BLEEDING VOLUMES AFTER REDUCTION OF THE BLOOD PRESSURE

Dog No.	Time of experiment, days after final stage of sym- pathectomy	Initial blood pressure, Mm./Hg.	Final blood pressure, Mm./Hg.	Amount of blood or plasma removed, per cent of c.b.v.	Terminal bleeding volume, per cent of c.b.v.	Duration of experi- ment, mins.
<i>(A) Blood Pressure Lowered by Histamine Administration</i>						
356.....	17	106	40	..	42	50
353.....	24	90	50	..	53	45
351.....	26	100	60	..	49.2	50
Average of three sympathectom- ized dogs.....					48.1	
Average of six control dogs (Roome, Keith and Phemister ²)					50.5	
<i>(B) Blood Pressure Lowered by Graded Hemorrhage</i>						
470.....	19	106	60	39	25.5	70
294.....	27	104	70	30	28	55
422.....	41	100	55	30	16	78
Average of three sympathectom- ized dogs.....				33	23.2	
Average of seven control dogs (same source)...				45.5	24.9	

experiment was from 16 to 28 per cent of the c.b.v. and averaged 23.2 per cent. This figure is very close to the average bleeding volume of the control dogs, 24.9 per cent.

DISCUSSION.—The observations described above upon the blood pressure of dogs during the three stages of complete sympathetic exclusion have confirmed Cannon's finding that the blood pressures tend to recover after each stage of the sympathectomy. However, they do not confirm the existence of a marked overcompensation, *i.e.*, there was no significant rise of blood pressure above the normal. After the right thoracic chain was removed half the animals maintained a blood pressure very slightly above normal and one-half fell below, but all of the readings, except on the first postoperative day, were within the normal range. Following removal of the left thoracic chain with section of the greater splanchnic nerve the greatest and most continued depression occurred. The abdominal sympathectomy usually produced no significant change in the blood pressure. The disagreement with Cannon's observations may be due to the different order in which the stages of sympathectomy were carried out in his and in the present experiments.

Further investigation is necessary to evaluate the relative importance of the portions of the sympathetic chain in the production of lowered blood pressure. Six of the animals described have been kept for periods of many months and all have shown blood pressure recovery that casts doubt on the idea of maintained hypotension following any type of sympathetic surgery. It must be remembered, however, that in these experiments normal animals have been used, while the surgical procedures which have been described by various authors are directed toward lowering an abnormally high arterial tension.

In Series II and III of the experiments described it was observed that the blood pressure depression, which follows section of the cervical spinal cord, and high spinal anesthesia in normal dogs, was absent in recently completely sympathectomized ones. This finding agrees with the commonly accepted idea that the depressor effect of these two procedures is due to the removal of tonic vasoconstrictor impulses passing down the cord from the vasomotor center and leaving it by the thoracolumbar outflow. The transient rise of the blood pressure which may occur at the moment of section of the spinal cord of normal dogs was also absent in the sympathectomized animals observed; this is as would be expected if the rise is due to stimulation of vasoconstrictor fibers at the point of section. Both these observations suggest that in recently sympathectomized animals there is no important vasoconstrictor outflow from the spinal cord below the first dorsal segment, and that in the intact animal all such outflow is carried through the sympathetic chains. The transient blood pressure depression when the spinal cord is cut in the sympathectomized dog may be due to sudden complete relaxation of the entire musculature below the point of section with temporary impairment of the venous return to the heart.

Comparison of the blood pressure maintained shortly after sympathectomy (average for 13 dogs, 106.7 Mm./Hg. one week after the final stage) with the blood pressures resulting immediately from high spinal anesthesia and cervical cord section in normal dogs (average for 12 dogs, 59.9 Mm./Hg.) indicates the presence in the former condition of some factor maintaining the blood pressure at a higher level than in the latter conditions, although in all there is presumably nearly complete loss of vasomotor tone. The question arises, then, is there a compensatory increase in the circulating blood volume? Freeman⁷ reported that a diminished blood volume may result from the continued vasoconstriction and high blood pressure produced by adrenalin. Does the reverse hold true for animals in which there is continued vasodilation? The bleeding volume of a series of completely sympathectomized dogs was found, however, to be slightly below the normal (Series V). When the reduced blood pressure is considered this finding seems to indicate that the circulating blood volume is very nearly normal, and certainly not increased. Hence some other factor than increased blood volume is responsible for the maintenance of the blood pressure after complete sympathectomy.

The bleeding volumes of completely sympathectomized dogs at reduced

blood pressures were also very nearly the same as in normal dogs under similar conditions (Series VI). Now, in the maintenance of the blood pressure after hemorrhage when the blood volume and viscosity are diminished, reflex vasoconstriction is an important factor in normal dogs. Thus, the circulating volume can be markedly reduced by hemorrhage before much fall of the blood pressure occurs, and even at reduced pressures of 50 to 70 Mm./Hg., the bleeding volume is found reduced to a less percentage than the blood pressure (Roome, Keith and Phemister⁵). The great similarity of the bleeding volumes of normal and recently sympathectomized animals with lowered pressures suggests that there is some vasoconstrictor mechanism effective shortly after removal of the sympathetic chains. Since there is no effect on the blood pressure from cervical spinal cord section or from spinal anesthesia it would seem that this mechanism is entirely peripheral and thus due to hormone or intrinsic vasomotor control.

The experiments (Series IV) in which blood pressure changes were not found to occur with electrical stimulation of the cut sciatic nerve seem to simply show that the reflex arc concerned is interrupted.

The fact that in the sympathectomized animals with lowered blood pressures, the bleeding volumes were approximately normal suggests that such animals should withstand hemorrhage, trauma, or an operation approximately as well as normal dogs. It must be noted that under laboratory conditions no obvious difference in general appearance or behavior follows complete sympathectomy.

SUMMARY.—Experiments are described on 27 dogs in which both sympathetic chains were resected by a three-stage technic. The blood pressure was measured by arterial puncture in 13 dogs, at intervals, between the various stages and for two to three weeks after the final operation. The effects of cervical spinal cord section, of spinal anesthesia, and of electrical stimulation of the central end of the cut sciatic nerve, were then tested. The bleeding volumes of completely sympathectomized dogs were measured at the slightly reduced blood pressures which occur after sympathectomy, and also after further reduction (to shock levels) by histamine and by bleeding.

CONCLUSIONS

(1) When the sympathetic chains are excised by the technic described, the blood pressure is lowered most extensively by the excision of the left thoracic sympathetic chain which includes a section of the greater splanchnic nerve, and no marked rise above the normal range of blood pressure occurs after any stage of the procedure.

(2) The circulating blood volume as estimated by the bleeding volume is not much altered and is certainly not increased after complete sympathectomy.

(3) The effects upon the bleeding volume of lowering the blood pressure by histamine or by hemorrhage are similar in completely sympathectomized dogs to the effects in normal dogs.

(4) The depressions of the blood pressure accompanying cervical spinal cord section, and high spinal anesthesia in the normal dog are absent in the recently sympathectomized animal.

(5) Electrical stimulation of the central end of the cut sciatic nerve produces no effect upon the blood pressure in recently sympathectomized dogs.

(6) The blood pressure after complete sympathectomy remains at a higher level than would be expected after withdrawal of all vasoconstrictor tone (*e.g.*, as by spinal anesthesia). The possibility of a peripheral vasoconstrictor mechanism is suggested.

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LUMBAR GANGLIONECTOMY AND TRUNK RESECTION IN CHRONIC ARTHRITIS*

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WE ARE all familiar with the results obtained by sympathetic ganglionectomy and trunk resection in vascular diseases of the extremities. Rowntree has suggested that lumbar ganglionectomy and trunk resection be tried in an instance of periarticular arthritis of the chronic type, accompanied by spastic vasomotor phenomena manifested by cold, clammy, pale, and occasionally cyanotic extremities.

The first patient was operated upon in June, 1926. The results were most gratifying.¹ Its use was confined to cases of chronic arthritis in which vasomotor spastic phenomena either preceded or accompanied the arthritis. In 1930, Rowntree² reported the results in 17 cases of chronic arthritis in which this procedure had been used. The operation was not employed unless the patients had been thoroughly studied, all foci of infection had been eradicated, all generally accepted medical measures had been used over a period of at least six months without improvement; and the patients reacted to the administration of typhoid vaccine intravenously with a high vascular index. In these 17 cases, the best results were obtained when the disease was confined to the hands and feet. When the knees and elbows were involved, the improvement was much less marked and slower in development. When the hip joints were involved, there was little or no improvement. In 1932, Henderson and Adson³ reported the operative results in 41 cases. They divided their cases into three groups: Group I, in which the disease was most advanced and there were numerous ankylosed joints. This group was composed of 20 cases, and sympathectomy was of no value. Group II, the border line cases in which the operation may be justified in the hope of reducing the pain and checking the disease. This group was composed of 11 cases and there was only about 20 to 30 per cent general improvement in these patients. Group III was represented by patients suffering from the periarticular type accompanied by the neurocirculatory disease. In these patients the operation afforded relief from symptoms and checked the arthritic processes. Group III, namely, the periarticular cases with vasomotor spastic phenomena, was again divided into two subgroups: one, where the arthritic changes were the direct result of the vascular disturbance—for instance, the sclerodactylia in acral-scleroderma, Raynaud's disease, thrombo-angiitis obliterans, in which there was spasm of the collateral arteries—and a second group of patients who suffer from cold, clammy, pale and cyanotic extremities preceding or accompanying the arthritic changes. The patient which I wish to report is in this second subdivision. From the results obtained to date,

* Read before the Philadelphia Academy of Surgery, April 1, 1935.

it is apparent that lumbar ganglionectomy is indicated only in a small percentage of the great number of patients suffering from arthritis. It has not been used in osteo-arthritis, hypertrophic or degenerative arthritis.

The patient's general health should be maintained at the highest possible point at all times to obtain the best results. The postoperative restitution of use of the involved parts should be very slow and conservative. Heat and other physiotherapeutic measures should be used with moderation as indicated. Orthopedic measures should be instituted to correct or overcome deformities.

CASE REPORT.—The patient, a white female, aged 16, was admitted to the Presbyterian Hospital December 30, 1932. Chief complaint, arthritis of both ankles and feet. The history dates back to six years before admission when the patient had pain and swelling of both feet and ankles. This disability continued for three months with subsequent complete relief until three years ago. Then she had pain in the right arm, hand, leg and foot, with swelling of these extremities and their respective joints. Accompanying this was pain and lack of motion of the left side of her face, with inability to talk. She was treated at the Johns Hopkins Hospital for this condition for six months with complete relief. In both instances the diagnosis was arthritis. She was then perfectly well until ten months ago, when she again developed pain, swelling, and tenderness in the right ankle and foot, and also to a lesser degree the same symptoms in the left foot and ankle. Accompanying these symptoms she constantly complained of the extremities feeling cold, and when the feet hung down they become bluish-purple in color. This was more pronounced on the right than the left lower extremity. Her condition became so severe that she was confined to bed. Medical treatment over these ten months produced no improvement. She had been carefully studied for foci of infection in the past. Her tonsils were removed nine years ago and her appendix one year ago. A maternal aunt and paternal grandmother had arthritis. Otherwise the family history was negative.

Physical examination disclosed a fairly well nourished white girl, 16 years of age, who was confined to bed. There was moderate pallor and lack of facial expression. Temperature, 99.1°F., pulse, 100; respirations, 21; blood pressure, 90/50. The physical examination was essentially negative except for the lower extremities. There was a moderate degree of muscular atrophy from disuse of both legs and thighs, more marked on the right than the left. There was a visible enlargement of the right knee joint. The right ankle was swollen, red and tender. Motion was impossible because of pain. There was no pain in the knee joint. The physical findings were similar in the left ankle and foot but less pronounced. When the feet hung down they became distinctly bluish-purple in color; more marked on the right than the left. This disappeared when the feet were elevated, and they became a blanched white. To palpation the surface temperature was much lower in the involved parts. This was more marked on the right than the left. The lowered surface temperature extended above the knee on the right and to the middle of the calf on the left lower extremity. There were no physical findings in the heart but the electrocardiograms suggested mitral stenosis with a question of coronary stenosis with myocardial degeneration. Roentgenologic examination of the feet and legs showed moderately advanced atrophic arthritis, more marked on the right side. "There is no appreciable narrowing of joint space. The bony joint surfaces and outlines are very slightly irregular. The zone proximal to the joint space is well preserved. There is considerable atrophy over the lower end of the tibia and fibula and all bones of foot. In the lower tibia this atrophy appears ground glass in nature. There is some definite thickening of peri-articular tissue. Conclusions: Evidence of moderately advanced atrophic arthritis." Blood count: hemoglobin, 89 per

cent; red blood cells, 4,190,000; white blood cells, 4,600. Urine, negative. The clinical diagnosis was atrophic arthritis accompanied by or secondary to a vasomotor vascular disease of the extremities.

The patient remained in the hospital for a period of five months on the services of Doctors Pemberton and Klein. During this time all types of medical treatment had been instituted, including baking and massage, diet, injections of vasodilators and the intravenous use of typhoid vaccine. She constantly complained that her extremities felt cold. Two months after admission a roentgenogram showed more generalized atrophy when compared with the earlier films. Doctor Rowntree saw her at this time and suggested the use of diathermy to the lumbar sympathetics in addition to the intravenous administration of typhoid vaccine. Though no thermocouple was used, there was a palpable elevation in the surface temperature of the involved parts after the intravenous administration of the typhoid vaccine, whereas the mouth temperature rose only one degree; thus the vascular index was satisfactory for lumbar ganglionectomy.

After five months of medical treatment with no improvement, the patient was transferred to the surgical service of Doctor Speese, and on May 5, 1933, I performed a bilateral lumbar ganglionectomy and trunk resection. A peri-arterial sympathectomy was performed on the left common iliac artery. There was immediate improvement in the surface temperature and color of the affected parts while still on the operating table. The postoperative routine of gradual introduction of exercise to the involved parts was instituted. The patient left the hospital five weeks after the operation, able to walk carefully with crutches.

Subsequent Course.—She continued with two crutches until two months after the operation, and one crutch for one month, and a cane for the succeeding three months. Since that time she has not used any artificial support.

When seen four months after operation she was using a cane, and walked with very little difficulty. Her general condition had improved greatly, the swelling of the parts had disappeared and there was only a slight degree of pain produced on motion of the involved joints. There was marked improvement in the lowered surface temperature and both feet were pink in color. She noted pains in the calves of her legs and dryness of the skin of the lower extremities. She was permitted to return to school.

After discarding the cane, only a limited amount of walking was permitted, but exercise was gradually increased. At first a twist of the ankle in walking would produce pain and slight swelling which would persist for 24 hours and then disappear.

On March 2, 1935, 22 months after the operation, her general appearance was that of a normal healthy girl. She had been able to attend school regularly for one and one-half years, and was able to walk an unlimited distance without any pain or disability, and has attempted dancing on a soft rug with no discomfort. She experienced slight pain in both ankles, more marked on the right, when she ran or jumped. The muscular atrophy had disappeared, the joints that were involved appeared normal in shape and size. The pains in the calves of the legs had disappeared six months ago. There was still some palpable difference in the surface temperature, though not nearly as pronounced, over the lower half of the right leg. There was no palpable lowering of the surface temperature on the left leg. A roentgenogram taken at this time showed no improvement in the atrophic disturbance in the bones, but there was no evidence that it had increased.

On April 1, 1935, the patient stated that she continues to notice a gradual increase in her ability to use the lower extremity, and to palpation there was no evidence of any lowered surface temperature in the right leg, which had been observed on March 2, 1935.

DISCUSSION.—This case is presented because it illustrates the type of arthritis which may be benefited by lumbar ganglionectomy and trunk resec-

tion. It is probable that the greatest improvement has not as yet been obtained, as more improvement is noted as time goes on.

A cervicothoracic sympathectomy may also be performed when this condition exists in the upper extremities.

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THE THERAPEUTIC EFFECTS FOLLOWING INTERRUPTION OF THE SYMPATHETIC NERVES*

REPORT ON THE ALCOHOL BLOCK IN CERTAIN ARTHRITIC AND VASCULAR CASES

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THE autonomic nervous system was described 200 years ago (1732) by Winslow.¹ After extensive studies in morphology, the next great contribution to the anatomy of these nerves was made by Gaskell (1886-1889). Langley (1889-1921) developed a new approach to the understanding of these nerves by discovering the action of a drug, nicotin. The effect of drugs and animal experimentation furnished most of our knowledge until 1923, when Royle and Hunter,^{2,3} attempting to aid cases of spastic paraplegia, employed a third method of study—that of interrupting the sympathetics and observing the effects on the disease. In isolated instances, others had used this method before, but the great modern impetus was given by their work. Today we are able to state that the autonomic nervous system has a definite relation to certain diseases, and interruption of the proper nerves will greatly benefit these diseases.

As we have reviewed the literature, we have been profoundly impressed with the fact that the value of each article has been to a large extent proportional to the knowledge of the anatomy and physiology displayed by the author. This statement cannot be too forcibly emphasized, therefore we give brief outlines of anatomy and physiology with diagrams to which we have constantly referred, and which we hope will be useful to the reader.

ANATOMY OF THE AUTONOMIC NERVOUS SYSTEM.—The autonomic nervous system is composed of two parts: the sympathetic and the parasympathetic. Because the former is embryologically and anatomically connected with the thoracic and lumbar segments of the spinal cord, it is frequently spoken of as the thoracolumbar nervous system. For similar reasons, the latter is often called the craniosacral nervous system. Basically, the two systems are constructed according to a somewhat similar pattern. As illustrated in Fig. 1, the sympathetic reflex arc consists of a receptor or visceral sensory (afferent) neurone with its fiber, a connector or preganglionic neurone and its fiber, and an effector or postganglionic neurone and its fiber.

Extending from the base of the skull to the coccyx, along the antero-lateral aspects of the vertebral column are two ganglionated sympathetic nerve trunks (Fig. 2). The ganglia are known as the vertebral ganglia and are in a general way segmentally arranged, except in the cervical region where there are only three sympathetic ganglia. From the first thoracic nerve to the

* Read before the New York Surgical Society, February 24, 1933.

second lumbar nerve the ganglia are connected to the spinal nerves by two rami, the gray and white rami communicantes. Elsewhere the ganglia are connected with the spinal nerves only by the gray rami. All of the ganglia are connected with each other by longitudinal fibers.

In addition to the vertebral ganglia, the sympathetic system has another

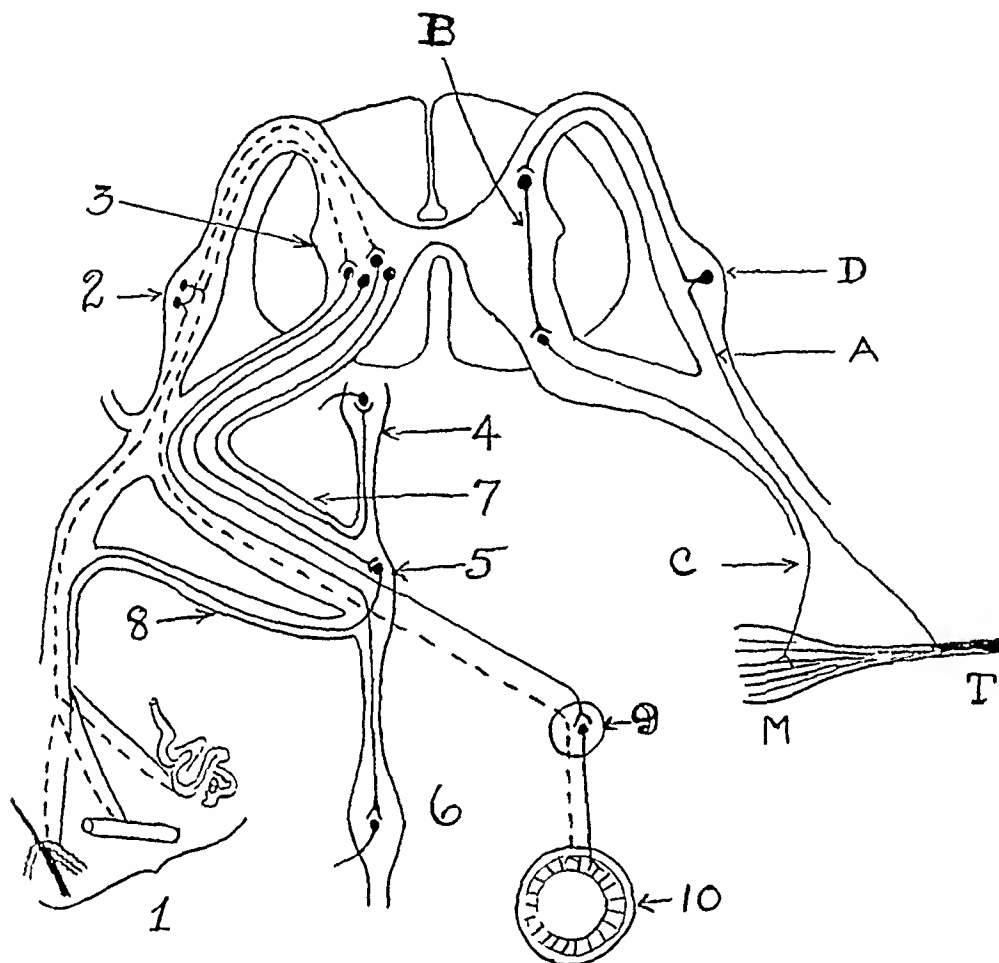


FIG. 1.—Reflex Arcs in the Cord. Left half of diagram, 1, 2, 3, etc., involuntary system. Right half of diagram, A, B, C, etc., voluntary system. (1) Group schematically shows hair, muscle, sweat gland and blood vessel equipped with visceral sensory or afferent fibers (dotted lines) and a postganglionic visceral motor fiber (solid line). (2) Dorsal spinal ganglion showing one visceral sensory neuron sending its fiber in the spinal nerve to the structures. Another visceral sensory neuron sends its fiber through the white ramus (7), the vertebral (5), and prevertebral ganglia (9), to a viscus (10). (3) Lateral horn or intermediolateral cell column showing four preganglionic cells whose fibers pass through the white ramus (7), and terminate at four different points: one preganglionic fiber forms a synapse with a postganglionic neuron in the sympathetic ganglion (5) attached directly to the spinal nerves; another forms a synapse in the ganglion above (4); a third forms a synapse in the ganglion below (6); a fourth passes through the vertebral ganglion (5) to form part of the splanchnic nerves, which terminate in a prevertebral ganglion (9). From (9) a postganglionic neuron extends to the viscus (10). A preganglionic fiber frequently extends two to four ganglia above or below its particular segment. (8) is a gray rami. (A)—Receptor or afferent fiber of the voluntary nerve system. (B)—Connector fiber. (C)—Excitor or efferent fiber. (D)—Dorsal root ganglion. (M)—Muscle. (T)—Tendon.

set of ganglia located about the aorta and its larger branches (Fig. 2). These are known as the prevertebral sympathetic ganglia. The celiac, superior mesenteric, aorticorenal and inferior mesenteric ganglia belong to this group. Fig. 1 illustrates the connections of the preganglionic fibers with these ganglia. Fig. 3 illustrates schematically the origin and distribution of the autonomic nervous system.

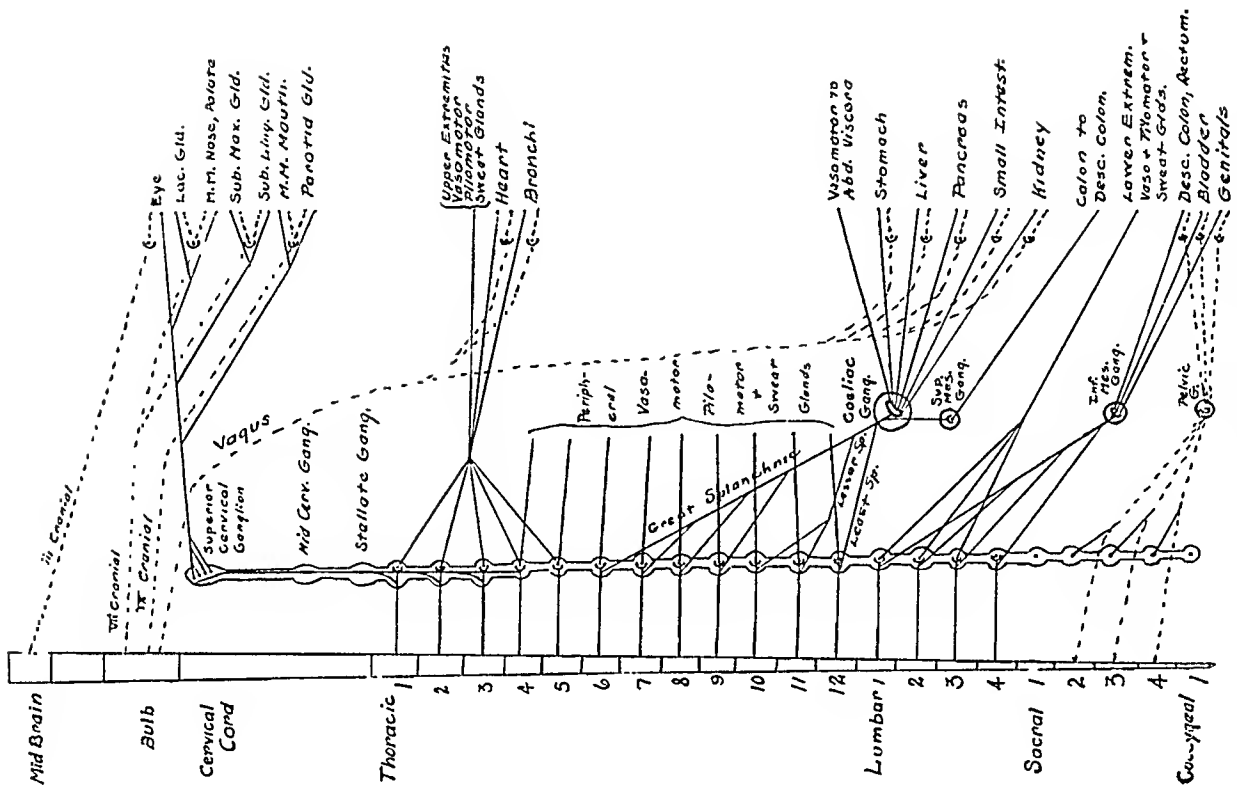


FIG. 3.—Diagram of the autonomic nervous system. The sympathetic division shown by solid blocked lines; the parasympathetic by dotted lines.

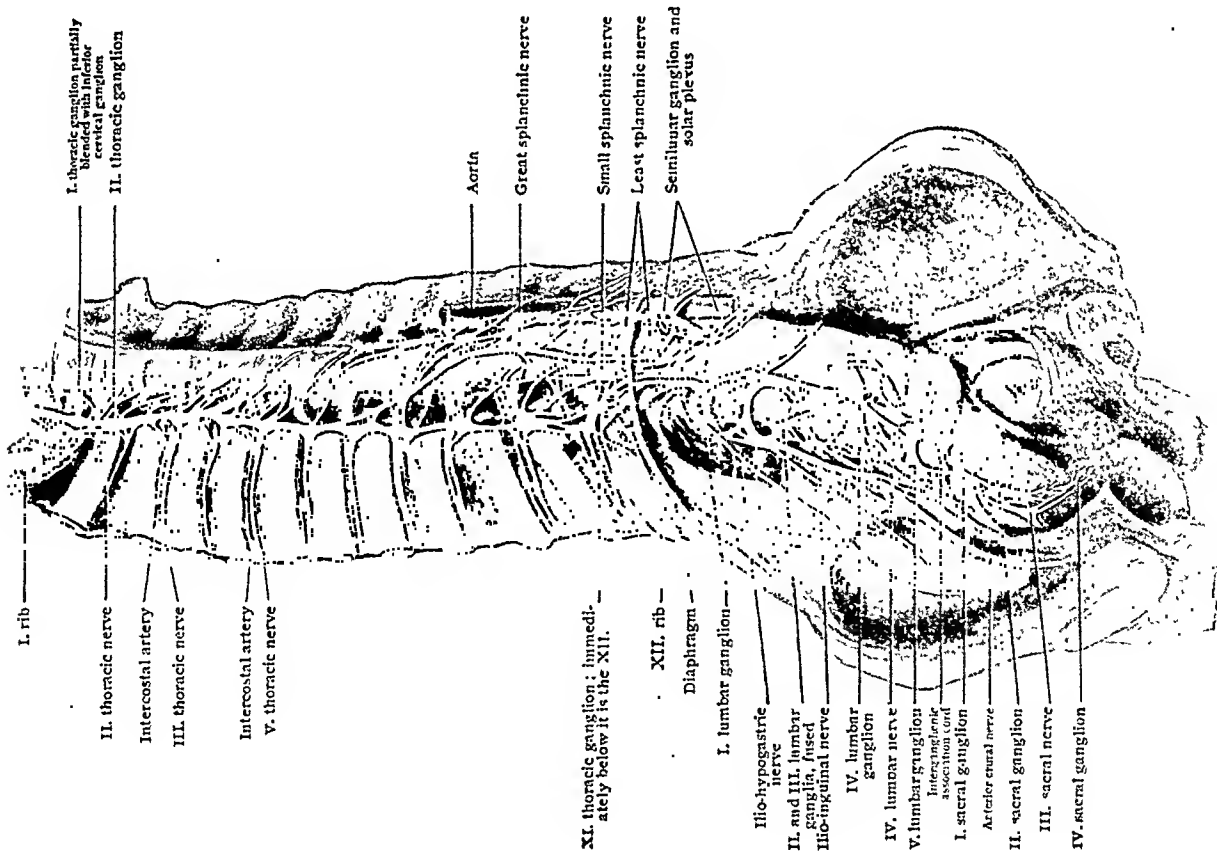


FIG. 2.—Dissection showing thoracic, lumbar and sacral portions of right gangliated cord and their branches (Piersol).

ALCOHOL BLOCK OF SYMPATHETIC NERVES

PHYSIOLOGY OF THE AUTONOMIC NERVOUS SYSTEM

	Sympathetics	Parasympathetics
Eye	Dilates pupil and widens palpebral fissure	Constricts pupil and narrows palpebral fissure
Salivary Gland	Controls ferment formation and constricts arterioles	Causes secretion of salts and water and dilatation of arterioles
Head and Mucous Membrane	Vasomotors	
Heart	Accelerates	Slows
Bronchi	Dilate	Constrict
Upper Extremity	Constricts blood vessels, pilomotor, causes "goose flesh" and sweating	
Stomach	Inhibits peristalsis and secretory activity	Stimulates
Liver	Stimulates conversion of glycogen into glucose	Opposes
Pancreas		Stimulates flow of pancreatic juice
Intestines up to Descending Colon	Inhibit peristalsis and secretory activity	Stimulate
Kidneys	Modify blood supply	
Descending Colon and Rectum	Relax	Contract
Sphincters	Contract	Relax
Lower extremities	Vasomotor, pilomotor, cause "goose flesh" and sweating	
Pain	Fibers are carried in autonomic nerves from viscera	

INTERRUPTION OF THE SYMPATHETIC NERVES.—One of the best methods of studying the autonomic nervous system is to interrupt various parts of it and then consider the physiologic and clinical effects which follow.

A. *Interruption of All the Sympathetic Nerves.*—Cannon⁴ completely extirpated all the sympathetic trunks in cats. The cats bred and fed their young in a normal way. They ate well and digested their food. Their metabolism was reduced about 10 per cent. They could not elevate their hair coat. They got a Horner's syndrome, but it was transient. They were very sensitive to cold. Kittens who had all sympathetics removed on one side developed symmetrically. In a warm quiet laboratory, where the sympathetics are not essential, they live quite comfortably. Cannon believes, however, that only in a protected environment could such animals survive.

B. *Interruption of the Cervical Sympathetic Nerves.*—Interruption of the cervical sympathetic nerves produces a syndrome first described in 1869 by

Horner⁶ as consisting of enophthalmos, miosis, pseudoptosis and cessation of sweating on the affected side of the face. It was 20 years later before the cervical sympathetic nerve was divided or resected in the hope that the resulting Horner's syndrome would benefit cases of exophthalmic goiter and glaucoma.⁵ According to Parsons,⁷ the benefit in two cases of exophthalmic goiter seemed to be due to a paralysis of Müller's muscle. There was no resultant decrease in the exophthalmos. Parsons stated further that he would hesitate to use the operation on both sides because of possible interference with night vision. Adson, however,⁸ reports that the condition, when bilateral, is rarely complained of unless unequal. He also states that there is no serious interference with vision in the dark. White⁹ found only a slight Horner's syndrome appearing when the upper dorsal ganglia were blocked, but if the inferior cervical ganglion is included a permanent Horner's follows. We have found this to be true in the cases we have done.

Cervical sympathectomy has also been done for bronchial asthma. Conflicting reports are given out as to the results obtained. When we realize that the constricting nerve fibers to the bronchi come from the vagus nerve and the dilating fibers come from the sympathetic nerves, then the removal of the cervical sympathetic ganglia for the treatment of bronchial asthma seems to have no anatomic or physiologic basis.

Formerly it was thought the lowest fibers to the heart ran from the stellate ganglion with the inferior cardiac nerve. Cervical sympathectomies were found to be not entirely effectual in stopping the pain of angina pectoris. In 1927-1930, various workers ^{10, 11, 12} showed that, in addition to the middle and lower cardiac nerves, afferent impulses from the heart also run across the posterior mediastinum to the upper dorsal sympathetic ganglia. Blocking or resecting these latter ganglia has been very successful in a large number of cases.

C. Interruption of the Sympathetic Nerves to the Extremities.—Probably more attempts have been made to benefit disease by interrupting the sympathetic nerves to the extremities than by their interruption to any other part of the body. In 1923, during Royle's³ extensive work on removing the sympathetic nerves for the treatment of spastic paralysis, he discovered the side operated upon was warmer and showed capillary dilatation. The profession was very quick to seize upon this idea and apply it to increase the circulation in many types of vascular disturbances.

It is now pretty well established that all of the vaso-constrictors to the upper extremity come off as gray rami from the inferior cervical and first and second thoracic sympathetic ganglia. If these three ganglia are resected or blocked, there is complete paralysis of all vasomotor nerves to the extremity. This has been substantially proved by Kuntz,¹³ White,¹⁴ and Adson.¹⁵

Complete vasomotor paralysis to the lower extremity is obtained by resection or blocking of the second, third and fourth lumbar sympathetic ganglia and trunk, because all postganglionic neurones and their axones (gray rami)

to all the spinal nerves below the first lumbar are supplied by the preganglionic fibers coursing through these three sympathetic ganglia.

In experimental animals after sympathectomy to the extremity, the circulation returns to approximately normal in ten days or two weeks.¹⁶ In a perfectly normal human being, the same thing might happen, though more slowly. There is abundant evidence to prove that when there is a vasomotor neurosis or exaggerated vasomotor tonus, as in cases of Raynaud's disease, Buerger's disease, and scleroderma, the release of the constricted blood vessels will last for a period of many months, if not permanently.^{8, 9} After a fairly thorough review of the literature and an appraisal of our work, we may say that great benefit has been reported in cases of Raynaud's disease, thromboangiitis obliterans, scleroderma and amputation stump pains.

From a surgical point of view, a most interesting observation has been made. Mulvihill and Harvey¹⁷ found that ligation of a dog's iliac artery close to the aorta was always followed by a 10° to 30° Fahrenheit decrease of temperature in the corresponding foot; but if lumbar sympathectomy was done at the same time as the ligation of the iliac artery, then no fall of temperature occurred.

D. Peri-arterial Sympathectomy.—In recent years, there have been few operations more widely discussed than that of peri-arterial sympathectomy, which consists in removing the adventitia with its nerve plexuses from a portion of a large blood vessel. Although others carried on experiments many years previously, Leriche¹⁸ in 1916 performed this operation for a number of clinical conditions and reported successful results in most of them. Until recently, there were more favorable than unfavorable reports on the results of clinical cases so treated. On an anatomic and physiologic basis, such a procedure must be justified by assuming that arteries to the extremities, like those of the thoracic and abdominal cavities, carry their sympathetic nerve plexuses from the aorta throughout their distribution. More recent work offers unquestionable proof that such is not the case (Fig. 4). Instead, the arteries of the extremities derive

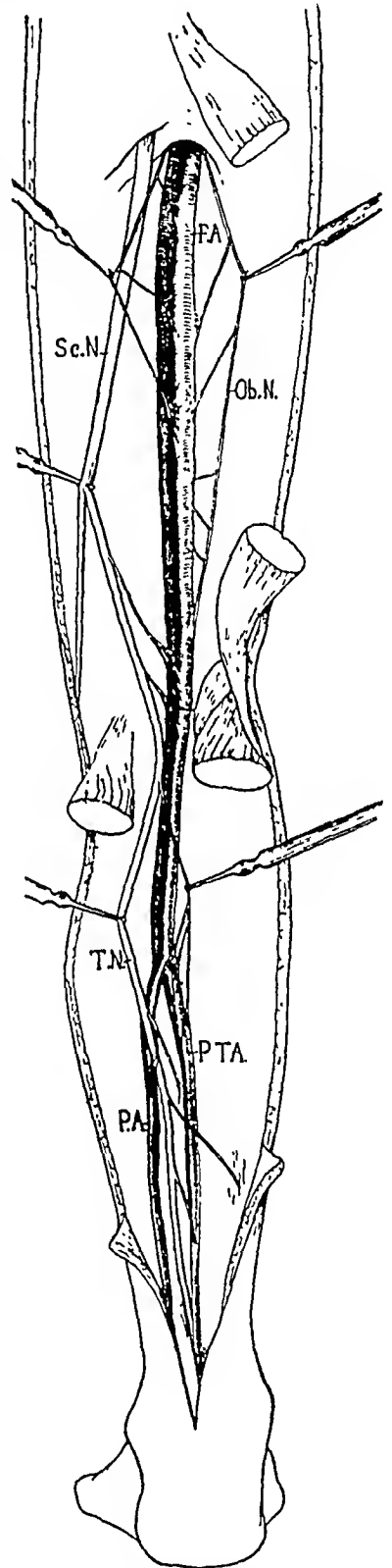


FIG. 4.—Illustrating the fact that arteries to the extremities derive their nerve supply mainly from adjacent peripheral spinal nerves. These arteries do not carry their sympathetic nerve plexuses with them from the aorta, as do the arteries to the thoracic and abdominal cavities (Kuntz).

their nerve supply mainly from adjacent peripheral spinal nerves.^{19, 20} Branches of these nerves, including fibers of the sympathetic (gray rami) and spinal ganglion origin join the peripheral arteries at intervals corresponding with the somatic segments. Formerly, Adson²¹ did a peri-arterial sympathectomy on the common iliacs in conjunction with lumbar ganglionectomy. To quote: "However, we soon learned that if on one side we did unilateral peri-arterial neurectomy in addition to lumbar sympathetic ganglionectomy, and on the other side we did lumbar sympathetic ganglionectomy alone, the changes in the surface temperature on the two sides were the same." Rogers and Heminway²² performed a peri-arterial sympathectomy on the carotid artery of a rabbit. They also divided the cervical sympathetic chain of a rabbit. The former procedure caused congestion of the rabbit's ear for about two days, but the latter procedure lasted longer. Horton and Craig²³ did a lumbar ganglionectomy on one side of a dog. They then did a peri-arterial sympathectomy on one lower extremity of another dog. They then injected mercury into the abdominal aortas of these two dogs. Dilatation was much greater in the extremity of the dog with the ganglionectomy. In two cases, White²⁴ injected the sciatic nerve for pain. At the same time, he noted an increase in the peripheral surface temperature comparable to that produced by sympathetic ganglionectomy or spinal anesthesia. We are forced to conclude, then, that peri-arterial sympathectomy brings about only slight sympathetic denervation of a peripheral artery, and there is no rational anatomic or physiologic basis for this operation as a clinical procedure.²⁵

E. *Interruption of the Sympathetic Nerves for Spastic Muscles.*—The sympathetic nerves to the extremities have been removed by Royle²⁶ and others in cases of spastic paralysis. In 1931, Royle had done more than 600 such operations with 0.5 per cent mortality. The assumption was that there is a relation of the muscle tonus to the sympathetic nervous system. Several surgeons^{27, 28, 29, 30} have followed cases operated upon by Royle. They believe that sympathetic nerves do not exist in skeletal muscles, and any benefit from sympathectomy in spastic conditions is due to increased blood supply and increased metabolism to the spastic muscles.

F. *Interruption of the Sympathetic Nerves for Amputation Stump Pain.*—Resecting or blocking the sympathetic nerves is of interest to surgeons if it will stop pain in amputation stumps. We have employed this procedure in one case—a traumatic stump of the middle of the left forearm. No improvement was noted. However, White and others¹¹ report excellent results in a few cases. It is well known to all surgeons that pain fibers, whether sympathetic or not, are carried in blood vessel walls,¹⁰ also that amputation stumps are often cold and their blood supply deficient. Interrupting the sympathetic nerves may benefit in those two ways.

G. *Interruption of the Sympathetic Nerves to the Colon.*—Unilateral or bilateral resection of the four lumbar sympathetic ganglia for cases of megacolon (Hirschsprung's disease) was first done by Wade and Royle,³¹

in 1927. Learmouth and Markowitz³² demonstrated that "electric stimulation of the corresponding nerves of the bowel leads to dilatation of the colon and to contraction of the internal sphincter of the rectum, and contraction of the internal sphincter has been demonstrated by Rankin and Learmouth in the human being, when nerves are stimulated." Morton and Scott³³ have developed a diagnostic test to detect the proper case of megacolon which will respond well to sympathectomy. They give a barium enema and ask the patient to attempt to empty the bowel—they then paralyze the sympathetic nerves with a spinal anesthetic and ask the patient to again try to empty the bowel. If most of the bowel is thus emptied it is regarded as a favorable case for permanent sympathetic interruption.

METHODS OF INTERRUPTING THE AUTONOMIC NERVOUS SYSTEM.—A. *By Extirpation*.—It goes without saying that the surest way of stopping all function in a part of the body is to remove that part from the body. As we have mentioned above, isolated cases of extirpation were done until 1924 when Royle³ and Hunter³⁴ reported results of their extensive work on animals, and the clinical results on a large series of spastic paraplegics. Following Royle's report, Adson,²¹ Diez,³⁵ Ito and Asami,³⁶ Loyal Davis and Kanavel,³⁷ White,⁹ and many others have done sympathetic ganglionectomy and ramisectomy for many clinical diseases. The permanency of such a procedure is not definitely known. White³⁸ quotes Brücke's work which points to the regeneration of fibers at the rate of 1 Mm. per day. He also quotes the work on cats and monkeys by Tower and Richter who proved by measuring the electrical resistance of the skin that it returned to normal in about 28 days after certain sympathetic fibers were cut. Of course excision of a nerve cell must destroy all function of that cell and its fibers. However, the function of this cell might conceivably be taken over by another cell. Judging by vasomotor paralysis in the extremities of human beings following sympathectomy, there is strong evidence to prove that it is permanent if all of the postganglionic fibers (gray rami) to the blood vessels of the extremity are resected.^{9, 39, 44} However, it is the opinion of W. D. Andrus that regeneration or recovery of local tone returns in a few weeks to a few months. For the technic of removal by operation the reader is referred to articles by Adson,¹⁵ Flothow and Swift,⁴⁰ and Stewart.⁴¹

B. *By Spinal Anesthesia*.—A second method of interrupting sympathetic nerve action is by spinal anesthesia. Of course, this is practical only in the abdomen and lower extremities. White²⁴ advises that the anesthesia should reach to the sixth dorsal segment; therefore, skin anesthesia must rise to the level of the xiphoid cartilage. One advantage is that after the effects are noted and found favorable, a lumbar sympathectomy can be done under the same anesthetic. The idea of giving spinal anesthesia for ileus was to paralyze the splanchnic sympathetic nerves, give the vagus control, and thereby increase peristalsis and relax sphincters. Physiologically, this is sound if there is no contra-indication for, or mishap with, this type of anesthesia. Woodbridge⁴² advises that to obtain full effects the following drugs should

not be used: ephedrine, atropine, chloroform, ether and epinephrine. White has always obtained complete vasodilatation to the lower extremities with spinal anesthesia and ephedrine given at the same time.

C. *By General Anesthesia*.—Scott and Morton⁴³ have found that vasomotor tone is lost under a general anesthesia of ether, nitrous oxide or avertin. This is temporary and not practical in every case, but it is a quick method of determining just what effects paralyzing the sympathetic nerves will have on the circulation to a part. Sympathectomy or blocking with alcohol may then follow.

D. *By Injection of Mixed Nerves*.—Injecting the mixed peripheral nerves with certain drugs produces paralysis of the sympathetic fibers contained therein. For instance, if the sciatic nerve is blocked as it emerges from the greater sciatic foramen, complete vasodilatation of the arteries of the lower leg and foot is obtained, and the increase in surface temperature is comparable to that obtained by lumbar ganglionectomy.^{20, 24, 37} Blocking other nerves of the extremities gives similar results over areas corresponding roughly to the peripheral distribution of the nerve injected.

E. *By Crushing or Dividing Peripheral Nerves*.—Smithwick and White⁴⁵ obtained the effects of ganglionectomy, lasting three to six months, by crushing with a hemostat certain branches of peripheral sensory and mixed nerves. Laskey and Silbert⁴⁶ accomplished the same effect by dividing those nerves and then immediately suturing. We have obtained similar results in three cases done by both methods.

F. *By Blocking*.—In 1925, Mandl⁴⁷ first advocated the method of blocking the sympathetic nerve ganglia and fibers by direct injection of procain in or about these structures. Soon afterwards, the method was taken up in this country by Swetlow,⁴⁸ White,¹² Woodbridge,⁴² Flothow,⁴⁹ and others. As a diagnostic test, White in 1929 began blocking the sympathetic nerves to the arms and legs with procain hydrochloride. He found that for a period of two to four hours after blocking with procain, all the effects of a ganglionectomy were secured; namely, paralysis of the vasomotors, suppression of sweating, and, he believed, relief of pain over the referred sympathetic nerves. Very soon after White's work, Flothow blocked the sympathetic nerves with alcohol in 64 various cases and reported very satisfactory results.

BLOCKING THE SYMPATHETIC NERVES.—A. *Advantages*.—(1) Thus far, no fatality or serious complications from blocking by procain or alcohol have been noted in the literature. (2) Blocking is a procedure which may be carried out in the clinic and does not necessarily require hospitalization of the patient. (3) Blocking may first be done with novocain and the effects noted while the needle is left in place; and after the desired effects are obtained, they may be made more lasting and possibly permanent by then injecting alcohol through the same needle. We now believe that some form of diagnostic test should always be made prior to the operative procedure so as to determine the probable efficacy of resection. (4) Blocking has the advantage over other methods of interrupting because it is selective, leaving the other

nerves of the extremity intact. (5) Blocking is superior to protein shock in that the maximum effect from paralyzing the vasoconstrictors is produced in the region desired without a generalized reaction with fever and malaise which requires hospitalization. (6) Occasionally, blocking offers a complete relief of symptoms for a prolonged time varying from a few days to permanence.¹²

B. *Disadvantages.*—Of course, success is absolutely proportional to the accuracy of the technic of injection. One is not justified in attempting to block these nerves and ganglia until he has perfected the technic on cadavers, and until he is familiar with the complicated anatomy and physiology. (1) The solution may not be injected in the right position anatomically. (2) The effects may not be as lasting as in ganglionectomy. (3) Extension of the injected fluid may take place and more nerves than necessary are blocked.



FIG 5.—Illustrates position of patient for dorsal block.

(4) Following alcohol injection, an operation, if indicated, might be technically difficult. (5) Theoretically serious injury may be done to surrounding structures but such has not been reported. Frequently the injected alcohol irritates the intercostal nerve trunks, resulting in intercostal neuritis which may last from a few minutes to four or five weeks.⁵⁰ This has happened in some of our cases but mild anodynes usually controlled the condition.

C. *Technic of Blocking.*—The technic of blocking described and performed by most workers is that of Labat.⁵¹ The first paper to attract our attention was that of Flothow, who described Lundy's method.⁴⁹ We have followed this method in practically every case. It has the advantage of being the same in all dorsal and lumbar injections. Briefly, the method is as follows: Place the patient prone on a Gatch bed with his head toward the foot of bed. Any part of the spine may now be flexed by elevating the part of the bed ordinarily used for raising the patient's knees (Figs. 5 and 6). This may be accomplished also by placing pillows under the chest or abdomen of

a patient lying in bed or on a table. Labat's needles and syringes are preferable. The intervals between transverse processes lie approximately opposite the spinous processes in the dorsal region and opposite the interspinous



FIG. 6.—Position of patient for lumbar block.

spaces in the lumbar region. The needle placed about $2\frac{1}{2}$ to 3 cm. lateral to the spinous processes is thrust directly forward until the transverse process or the body of the vertebra is struck. Procain is continuously injected ahead

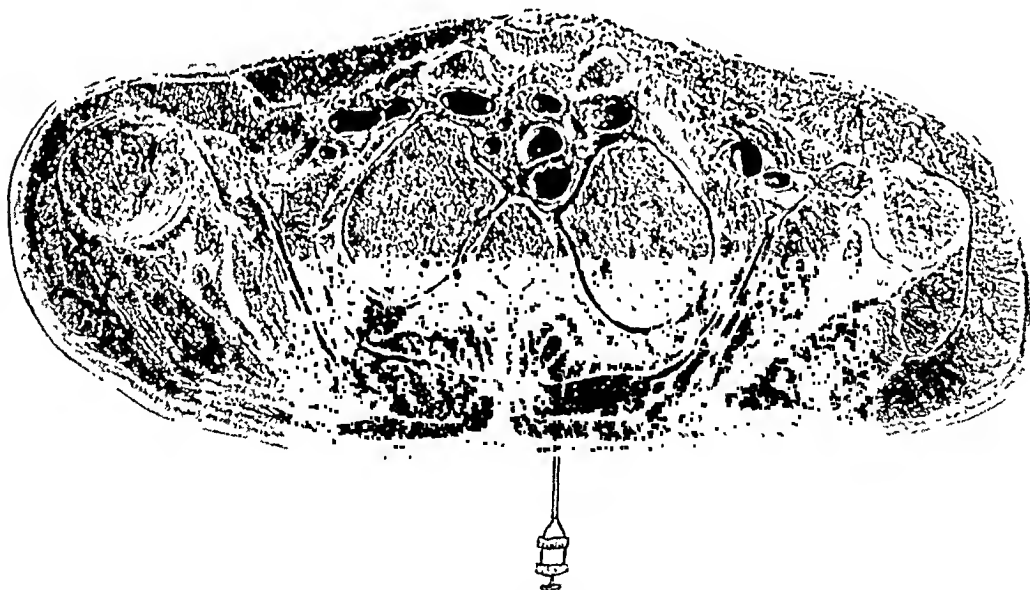


FIG. 7.—Cross-section through the upper dorsal region showing the needle in place for sympathetic nerve block. We use Lundy's technic of direct insertion of the needle.

of the advancing needle (Figs. 7 and 8). By slightly shifting the needle it is, in a way, slid around the side of the vertebra, reaching its anterolateral aspect at which point the sympathetic ganglion and nerve fibers lie. In the dorsal region the posterolateral aspect of the vertebral body is usually reached

between 4 and 5 cm. from the skin. The sympathetic ganglion is reached between 5 and 6 cm. from the skin. In the lumbar region the body is usually about 6 cm. and the sympathetic ganglion about 7 or 8 cm. from the skin. Most workers have used rather large quantities of procain and alcohol so as to be sure of surrounding the sympathetic ganglia. We have tried to be a little more selective and have used rather small quantities of solution, varying from 2 to 5 cc. We have always used 2 per cent procain and absolute alcohol. In one patient we blocked the sympathetic nerves simultaneously to two extremities. At a later date the sympathetic nerves of the other two extremities were injected. There have been no serious complaints from patients subjected to the procedure.

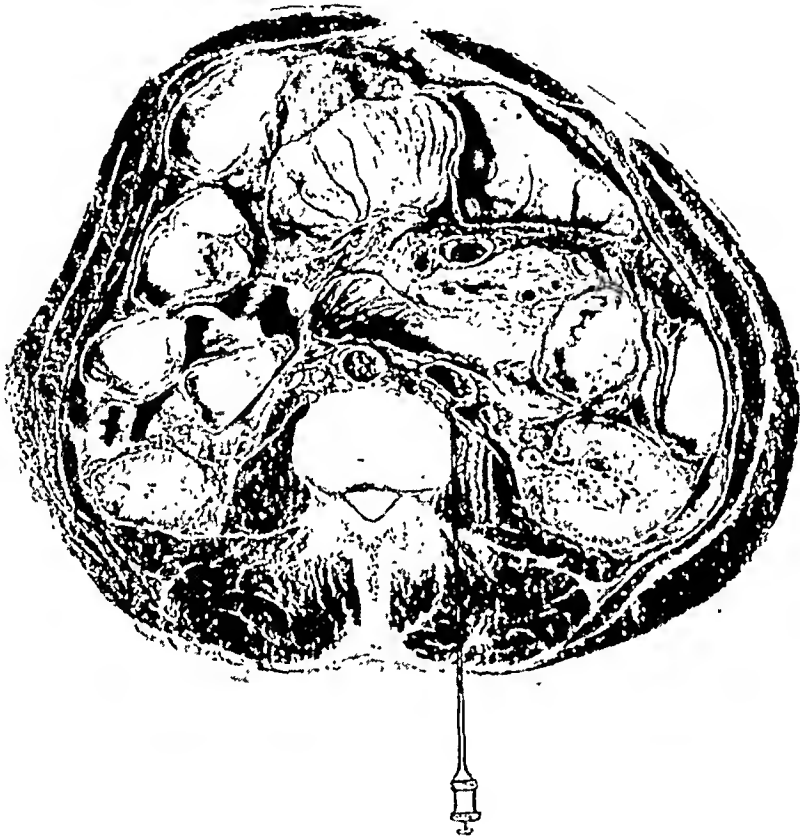


FIG. 8.—The needle in place for lumbar sympathetic nerve block.

All of our injections have been done when the constant room temperature of our laboratory was about 65°F. The patient was usually in the laboratory for 15 minutes before initial readings were taken. We have taken surface temperature readings of our nerve blocks as follows (Fig. 9): (a) Readings at various levels over anterior and posterior surfaces of both extremities. (b) Then block the sympathetics of one extremity with procain, leave needles in place, wait 15 minutes, then take readings on both extremities. (c) Inject alcohol through needles which are still in place, waiting 15 minutes to repeat readings on both extremities. (d) Take readings thereafter at weekly or monthly intervals.

D. Duration of Block.—The duration of the alcohol block is variously

estimated. To date, relatively few cases have been treated, and in so new a field certainty is still questionable. To my knowledge, two anginal cases done by White are the longest on record.¹² He reported complete block existing after intervals of one and five years. I know of only one autopsy after an injection of alcohol. White had a case of aortic aneurysm, which was completely relieved of pain, but death occurred three months later as

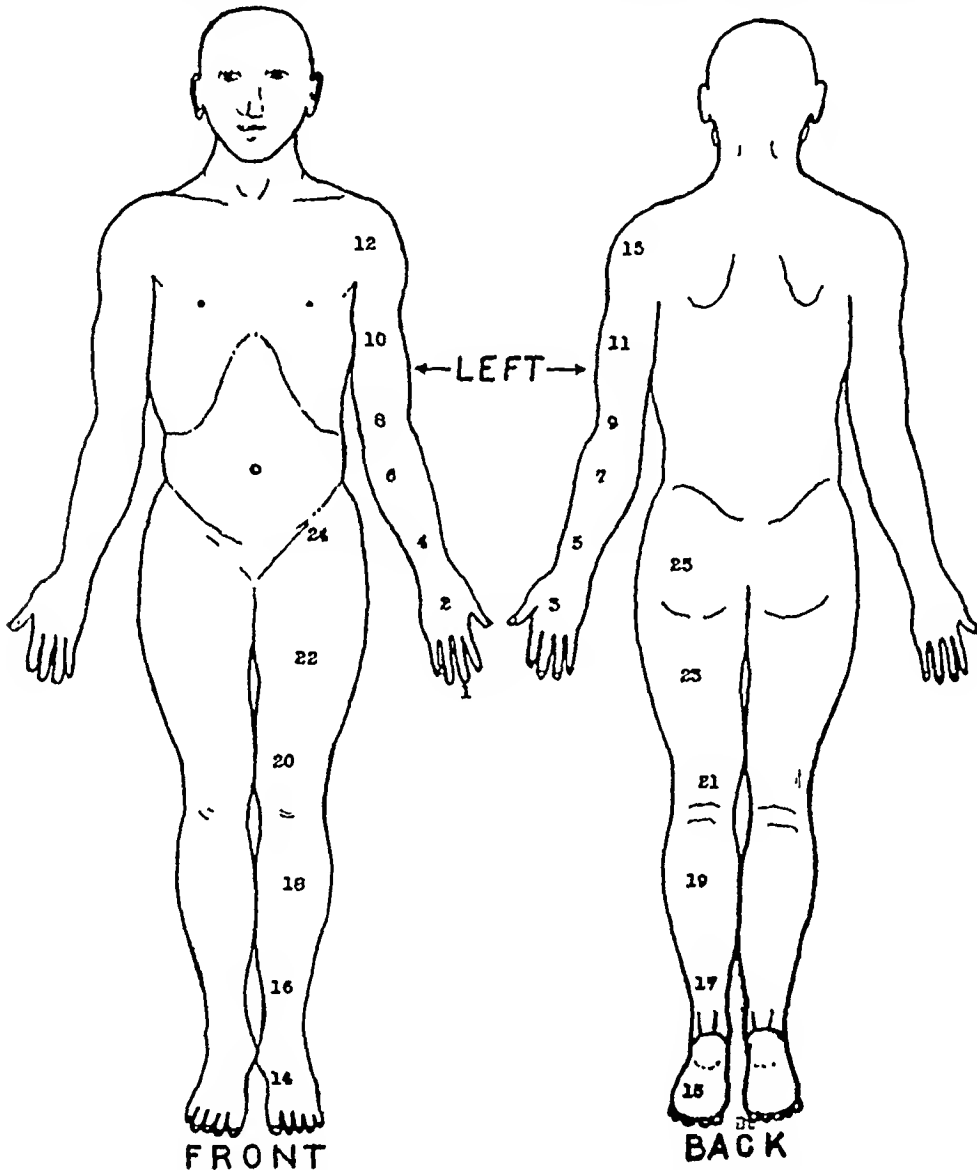


FIG. 9.—Shows points at which surface temperature readings were taken.

the result of an anterior perforation of the aneurysm. Autopsy showed definite scars about 1 cm. in diameter in the region of the first and second dorsal foramina. The small fibers of the rami were imbedded in the scar and it was impossible to follow them through it. The scar did not involve the spinal nerve trunk, although it partially surrounded it.

INTERRUPTING THE SYMPATHETIC NERVES IN ARTHRITIS.—The only sympathetic nerves going to the upper extremity are the gray rami from the

inferior cervical and first and second thoracic ganglia. All sympathetic nerves to the lower extremities are supplied through preganglionic fibers to and through the first, second, and third lumbar ganglia, hence these two sets of ganglia must be blocked if all four extremities are to be treated.

A. *Reports from Other Clinics.*—Rountree,⁵² in 1926, first suggested that interrupting these nerves be tried in cases of polyarthritis. He recommended that the procedure be limited to young persons who have shown no improvement with medical treatment and who complain of cold, wet, pale, clammy skin, and painful, swollen, tender joints with atrophy and contraction of the muscles, and especially those cases where the arthritis was worse in the hands, wrists, feet, and ankles. Flothow^{53, 49} reports great benefit in a few cases of arthritis. He states that a Japanese has performed sympathectomies in 120 cases with uniformly excellent results. White¹⁴ did a ganglionectomy on two cases with no improvement in joint stiffness or pain, but stated that both patients enjoyed warm dry hands instead of cold clammy ones. Leriche⁵⁴ has used the procedure in traumatic arthritis, with unusually good reports of improvement from chronic vasomotor spasm, edema, decalcification and pain in the injured joint. Enthusiastic reports are greatly in the majority.

B. *Alcohol Block in Patients with Rheumatoid Arthritis.*—Based on reports from other clinics, as to the type of case which responded best to sympathetic interruption, we chose patients whose arthritic manifestations were confined largely to the hands, feet, or both, and whose extremities showed vasomotor disturbances as indicated by cold clammy hands and feet. Care was taken to select patients whose joints showed primarily peri-articular swelling and increase of joint fluid rather than those who showed hypertrophic joint changes.

Altogether, 11 cases with rheumatoid arthritis were studied. Their average age was 41.9 years. The duration of symptoms averaged 18 months for ten cases and seven years for one case. Every case was selected from the arthritis clinics at Bellevue Hospital and Cornell Clinic and carefully worked up. All had been under observation for several months and were believed to be free from foci of infection. Several of them had been treated with streptococcus vaccines, physical therapy, diets, *etc.*, without beneficial results. The clinical impression was confirmed in all cases by positive streptococcus agglutination with arthritis hemolytic streptococci.⁵⁵

The technic of blocking was similar to that already described. In the dorsal region, the injection was usually made about the area of the second thoracic ganglion. In several instances, the first and third were also injected, but as a rule this appeared to be unnecessary, as no additional temperature change was obtained, the solution spreading from the second sufficiently to block the first and third. The surface rise in temperature of the upper extremities was good (Table I), even though all the sympathetic nerves could not have been blocked unless the inferior cervical ganglion area were included.

TABLE I

RÉSUMÉ OF RESULTS WITH ALCOHOL BLOCK IN PATIENTS WITH RHEUMATOID ARTHRITIS

Case	Site of Injection *	Alcohol Injected †	Increase in Temperature ‡ Following Injection			Remarks
			Toc or Finger	Kncc or Elbow	Inguinal or Shoulder	
1	Right lumbar 1 and 2...	10 cc.	12.3°	2.4°	0.3°	
2	Left dorsal 1, 2 and 3...	5 cc.	0.0°	0.0°	0.0°	Missed
	Right dorsal 1, 2 and 3.	5 cc.	2.5°	0.0°	0.0°	Missed
	Right lumbar 1, 2 and 3.	5 cc.	12.0°	3.2°	1.9°	
	Left lumbar 1, 2 and 3..	5 cc.	7.1°	4.9°	0.8°	
3	Left lumbar 1, 2 and 3..	5 cc.	0.0°	0.0°	0.0°	Missed
	Right dorsal 1, 2 and 3..	5 cc.	4.5°	1.0°	1.0°	
	Right lumbar 1, 2 and 3.	2 cc.	4.4°	5.1°	2.0°	
	Left dorsal 1, 2 and 3...	2 cc.	12.4°	7.9°	2.1°	
4	Left lumbar 1, 2 and 3..	4 cc.	15.5°	0.3°	0.0°	
	Left dorsal 1 and 2....	2 cc.	5.7°	2.8°	3.7°	
	Right lumbar 1, 2 and 3.	4 cc.	8.7°	4.4°	2.6°	
	Right dorsal 1 and 2....	2 cc.	10.4°	4.8°	2.0°	
5	Left dorsal 2.....	2 cc.	20.5°	6.2°	2.0°	
	Right lumbar 1, 2 and 3.	5 cc.	4.6°	4.5°	1.2°	
6	Right lumbar 1, 2 and 3.	4 cc.	22.0°	4.6°	2.1°	
	Left lumbar 1, 2 and 3..	5 cc.	17.5°	2.7°	0.7°	
	Left dorsal 2.....	5 cc.	14.6°	5.5°	2.7°	
	Right dorsal 2.....	4 cc.	14.9°	7.9°	3.5°	
7	Left lumbar 1, 2 and 3..	4 cc.	7.6°	1.0°	0.9°	
	Right lumbar 1, 2 and 3.	4 cc.	7.0°	0.8°	1.2°	
8	Right dorsal 2, 3 and 4..	21 cc.	12.8°	6.1°	0.5°	
	Left dorsal 2, 3 and 4...	2 cc.	4.5°	2.9°	0.6°	
9	Left dorsal 1 and 2....	4 cc.	12.1°	2.6°	1.2°	
	Left lumbar 1 and 2....	4 cc.	11.2°	3.1°	1.0°	
	Right dorsal.....	4 cc.	9.0°	6.1°	4.4°	
	Right lumbar 1 and 2...	4 cc.	0.0°	0.0°	0.0°	Missed
10	Left dorsal 2.....	5 cc.	10.9°	5.5°	1.8°	
	Right dorsal 2.....	5 cc.	10.6°	6.4°	3.7°	
11	Left dorsal 1 and 2....	5 cc.	7.5°	6.8°	4.2°	
	Right lumbar 1, 2, 3 and 4	5 cc.	7.3°	3.6°	1.4°	
	Right dorsal 1 and 2....	4 cc.	13.3°	12.3°	4.7°	
	Left lumbar 1 and 2....	4 cc.	20.0°	3.3°	0.0°	

* The figures refer to the ganglion areas injected.

† Under "alcohol injected" are given the amounts of absolute alcohol injected into or around each ganglion.

‡ All temperature recordings are in Fahrenheit.

To do so would have produced a Horner's syndrome and we did not think this justifiable in cases of arthritis.

In the lumbar region, we usually blocked the first, second and third ganglion areas. All sympathetics to the lower extremities should be blocked even by injecting the second and third. In one case we resected the lumbar second, third, and fourth sympathetic ganglia and rami on the left side but, because of numerous old abdominal adhesions, we did not resect them on the right side. Thirteen weeks later, we blocked the first and second lumbar with procain and alcohol. Five days later the blocked extremity (right) was about 1°F. warmer than the side operated upon (left). This case would lead us to believe that alcohol block is as satisfactory as ganglionectomy.

Two to 5 cc. of 2 per cent solution of procain were first injected and, with the needles still in position, the patient's condition was observed for at least 20 minutes. If temperature changes took place in the extremities and no unfavorable symptoms or signs developed, such as a Horner's syndrome, 2 to 5 cc. of absolute alcohol were injected in each area and the needles withdrawn. A summary of temperature changes following the alcohol injections is given in Table I. The temperature readings were made 15 to 30 minutes after the alcohol had been inserted, at which time the patients appeared to have obtained their maximum temperature rise in the extremities.

Considerable variation occurred as regards temperature elevation among the different patients and different extremities of the same patient. In three instances, the sympathetic fibers appeared to have been missed entirely. The greatest change is observed at the tips of the fingers and toes, considerably less change at the elbow and knee, and only a very slight variation at the shoulder and inguinal region (Table II).

TABLE II

AVERAGE RISE IN TEMPERATURE IN DIFFERENT CASES OF ARTHRITIS

	Great Toe	Knee	Inguinal Region	No. of Extremities
Lumbar Injections.....	11.6° F.	3.3° F.	0.97° F.	12
	Finger Tips	Elbow	Shoulder	
Dorsal Injections.....	10.9° F.	5.6° F.	2.2° F.	15

The patients subjected to alcohol block were all observed for several months to a year, and surface temperature readings repeated at varying intervals. The increased temperature lasted an average of six months. The duration of the temperature changes varied considerably in individuals and extremities of the same individual, depending probably on the extent of the alcohol infiltration in and about the nerve fibers and cells, upon the reaction of the individual and perhaps upon the dilution of the absolute alcohol by the procain solution. To inject the alcohol without procain would produce the maximum block, but it would subject the patient to an unnecessary

amount of pain and at the same time eliminate the opportunity to observe the effects of a preliminary procain block. We have not as yet an accurate method of measuring the permanent effects following interruption of the sympathetic nerves. If we knew the total blood flow through a part, or the total heat given off, we would have an accurate method of measuring the temporary and permanent effects following interruption of the sympathetic nerves. We cannot obtain this information with the instruments now used.

Of considerable importance is the effect of this procedure on the arthritic process. On the whole, the results in this respect were very disappointing. Although two patients showed definite diminution of the arthritic process, the others showed little or no improvement in the joint condition. While the number of cases in this series is too small to warrant definite conclusions, it seems altogether unlikely that the course of the disease is favorably modified by interrupting the sympathetic nerves.

On the other hand, symptoms related more closely to faulty circulation were definitely improved. The change of cold clammy hands and feet to ones warm and dry was appreciated by the patients. The feeling of numbness, so frequent in patients of this type, was most often completely relieved.

Considerable attention was directed toward observing and recording unfavorable signs and symptoms. Almost all patients complained of some pain at the site of injection, but this usually subsided in a few hours to two days, and was never severe enough to be a serious factor. Difficulty in breathing was also complained of in a few instances, but this also disappeared after a few hours or a few days. Following injection of the lumbar nerves three patients developed hyperesthesia and myalgia in the thighs. With two of these patients the symptoms were mild and passed away gradually in one to two weeks. With the other one the distress was quite severe, and remained a source of constant annoyance for a period of approximately six months. He was able, however, to proceed with his usual occupation. Horner's syndrome was observed in several of the patients but it generally subsided in a few hours or a few days. In one instance, the signs of Horner's syndrome were marked, and persisted one year after the injection, although the patient said it caused him no pain or inconvenience. During the year the signs gradually became less marked, and at last examination were only moderately noticeable.

Associated with temperature changes in the extremities is a marked improvement in the circulation. At times the fingers and toes take on a reddish blush which persists for several days. The extremities become warm and dry instead of being cold and clammy.

Alcohol Block in One Case of Raynaud's Disease with Arthritis.—CASE REPORT.—J. J., male, aged 22, barber, admitted to Bellevue Hospital February 9, 1932, with a history of painful, swollen, clammy hands and feet of nine months' duration. In addition, there was pain in the elbows, shoulders, and knees. Physical examination was unimportant except for that found in the extremities. The hands were cold, clammy, and

ALCOHOL BLOCK OF SYMPATHETIC NERVES

bluish in color, these signs increasing in extent during examination and decreasing again when placed under the bedclothes. The proximal interphalangeal joints of the hands, as well as of the feet and ankles, were slightly swollen. This patient also had marked vasomotor disturbances of the face, neck, and tongue, as was indicated by the ready flushing of these structures from even a slight amount of emotional excitement. A diagnosis of Raynaud's disease complicated by some rheumatoid arthritis was made.

Five cc. of a 2 per cent procain solution injected into the first, second, and third left thoracic sympathetic ganglion areas resulted in a marked rise in surface temperature of the left arm (Table III). As there were no unfavorable effects, 4 cc. of absolute alcohol were also injected into each area. After one week, the sympathetic nerves to the right upper extremity were similarly blocked.

TABLE III

RISE IN TEMPERATURE IN ONE CASE OF RAYNAUD'S DISEASE

	Finger Tips	Elbow	Shoulder
Left.....	22.8° F.	6.5° F.	1.8° F.
Right.....	10.2° F.	5.2° F.	2.4° F.

Following the alcohol injection the patient developed a mild intercostal neuritis which cleared up in two weeks. The symptoms and signs of Raynaud's disease completely disappeared and remained so for nine months, the period of last observation. The arthritis, on the other hand, showed little or no improvement. During the nine-month period following the injection, the patient was able to carry on his usual occupation, which he was not able to do prior to the treatment.

Alcohol Block in One Case of Thrombo-Angiitis Obliterans.—CASE REPORT.—W. B., aged 45, an electrician, was admitted to Bellevue Hospital April 4, 1932. He gave a history of pain in the feet and calves of the legs of eight months' duration, with coldness and bluish discoloration of the toes of the left foot. There was also a prickly sensation in the toes and fingers. One year previously he had had similar symptoms which necessitated amputation of the second toe of the left foot for gangrene. He had also had a perforated gastric ulcer ten years previously. Physical examination revealed marked abnormalities in the extremities. The tip of the third toe of the left foot was almost black in color, while that of the fourth toe on the same side was dark purple. The left dorsalis pedis pulsations were feeble and the right entirely obliterated. The blood pressure was 160/100 and the urine showed three plus albumen.

On April 14, 1932, the left second, third, and fourth lumbar sympathetic ganglion areas were blocked with 2 per cent procain and then with absolute alcohol. Within 15 minutes after the procain injection the toes of the left foot were 10.7° F., the knee 2.6° F., and the inguinal region 1.1° F. warmer.

Rapid improvement in symptoms and signs occurred, and the patient was discharged from the hospital five days after treatment. On January 30, 1933, more than nine months after the injection, the patient stated that he had been symptom free the entire time, except for some pain in the legs which followed brisk walks of over one-half mile.

This case is one of eight so treated. We are enthusiastic about alcohol block in such cases. We greatly prefer this form of treatment to protein shock or injecting or cutting the peripheral sensory nerves. With the latter procedure, most careful technic must be used or else serious damage will be done to blood vessels that are barely able to carry on, and to tissues with scarcely any resistance to trauma and infection.

CONCLUSIONS

(1) Diseases definitely benefited by interrupting the sympathetic nerves are: Raynaud's, thrombo-angiitis obliterans, scleroderma, cardiac and aortic pain, megacolon.

(2) Arthritic cases with marked vasomotor spasm and cold clammy extremities are greatly helped symptomatically, but there seems to be little or no benefit on the progress of the disease itself.

(3) The diagnostic procain block should always be done before an attempt is made to permanently interrupt the sympathetic nerves.

(4) Blocking the sympathetic nerves with alcohol seems to be an excellent substitute for operative procedures.

(5) The technic of blocking should be carried out only after acquiring a thorough knowledge of the anatomy and physiology of the autonomic nervous system and after many trials on cadavers.

(6) Peri-arterial sympathectomy is not supported on anatomic and physiologic grounds and is a poor substitute for interruption of the gangliated cord and rami.

(7) With our present technic, it is impossible to interrupt all sympathetic nerves to an extremity without interrupting sympathetic nerves to other parts of the body, *e.g.*, blocking the sympathetic nerves to the arm produces a Horner's syndrome and also blocks some of the sympathetic pathways to the organs of the chest. Blocking the sympathetic nerves to a lower extremity also interrupts sympathetic fibers to certain lower abdominal and pelvic viscera. Therefore, one must decide whether or not the good primary effects desired are valuable enough to warrant producing the undesired secondary effects. A study of the secondary or associated physiologic effects adds to our knowledge of the autonomic nervous system.

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THE USE OF AVERTIN (TRI-BROM-ETHANOL) IN NEUROSURGERY

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ANESTHESIA in neurosurgery is one of the most important factors to be considered if one is to gain adequate and unhampered exposure of various regions of the brain. A "slack" brain need seldom be damaged in gaining access to most tumors or structures. A tense, edematous brain is usually damaged to some degree. The proper use of avertin (tri-brom-ethanol), we feel, as an adjunct to novocaine and ether anesthesia favors, in no small degree, the chances of being able to work without undue intracranial tension.

Our experiences with the drug in some 250 cases have impressed us with certain details regarding dosage in relationship to various lesions of the brain which may be of use to others. About 40 per cent of our cases did not require ether in addition to avertin and when the use of ether was necessary the amount was greatly reduced. The juvenile or apprehensive adult patient may be given the drug in his room and the operation started without crying, struggle, or cough with the subsequent heightening of intracranial pressure. Postoperative nausea and vomiting seem less where the decreased amounts of ether have been used. Postoperative vomiting is almost nil where novocaine and avertin alone are used. The alterations in pulse and blood pressure have seldom been of serious moment when the smaller dosages of avertin were employed. A certain fall in blood pressure usually occurs, however. Among the disadvantages of using avertin are the fact that its effect cannot be terminated at will. Ephedrine and coramine have been used with some success in this regard (Raginski,²⁰ Bourne,¹¹ Wood⁴¹). It is also quite impossible to predict the degree of narcosis that any given patient will have. Two patients of similar weight, age, adiposity and with similar lesions of the nervous system may experience quite variable depths of narcosis. For this reason the drug is often given in divided doses. Experience has shown that the very old or the very debilitated patient does not tolerate the drug well in usual doses. However, it may be used in people of the sixth decade or over without harmful effects if the above-mentioned precaution is heeded.

Method of Administration and Dosage of Avertin.—Avertin is used either in the crystalline form or as avertin fluid (dissolved in amylene). As a rule the drug is used in a 3 per cent solution, given per rectum. The doses originally recommended, 100–150 mg. per Kg. of body weight, are considered

too high for routine use in neurosurgical procedures unless given in divided doses. If little effect from 30 to 50 mg. per Kg. is noted after some 15 to 20 minutes the remainder may be safely given as a rule. It has been our practice to give 70 mg. per Kg. of body weight as an average total dose.

Bourne uses dosages from 125 to 150 mg. and has reported 1,000 cases without death, the proportion of the cases having a complete narcosis being 30 per cent. Saklad³² uses 130 mg. per Kg. divided in order to give 70 mg. first, the rest being given in five to ten minutes. Watter¹⁰ uses dosages extending from 60 to 120 mg. per Kg. securing complete narcosis in 54 to 60 percentage of instances. Stumpf³⁸ gives between 70 to 90 mg. per Kg. Field²⁰ advises 80 to 100 mg. per Kg. and indicates that the doses varying from 60 to 70 mg. per Kg. are the safest. Dott¹⁸ uses 100 mg. for neurologic procedures. Kreuter²⁷ gives 100 to 150 mg. The concentration of the avertin in the rectal tap varies between 2 and 3 per cent. The principle and well-known danger of the use of avertin lies in respiratory failure of which Anschütz¹ has made a very thorough study. From his study he concludes that deaths in most of the cases are accidents of mechanical origin. There is an early relaxation of the jaw and pharyngeal musculature permitting the tongue to fall back and obstruct the respiration. Such accidents could have been prevented by a careful observation of the patient, keeping them on their side or by the judicious use of an airway. The intravenous administration of the drug advised by Kirschner²⁶ is of limited use and for short narcoses only.

Sebening,³⁶ Anschütz² and Gyllensvärd²⁴ have noted both experimentally and clinically that the drug is absorbed in adipose and nervous tissues more rapidly than elsewhere. These tissues also give up the drug more slowly than others. It is a commonly noted fact that an adipose individual will tolerate a higher dose of the drug than an emaciated one of the same weight.

Avertin and Neurosurgery.—Only a few references on the use of avertin anesthesia in neurosurgery are available. Of the cases reported many are those of avertin anesthesia used for diagnostic procedures only. No mention is made of neurosurgery by Goldschmidt and Harvey²² in their study of the American literature. In 1927, Kreuter²⁷ advised its use in neurosurgery at dosages of 100 to 150 mg., the total amount being 10 to 12 Gm., with the concentration of the rectal tap at 3 per cent. Borchardt¹⁰ thought avertins use in neurosurgery inadvisable. Schulze³⁴ used avertin in cases necessitating burr holes or bone flaps, mixing it with magnesium sulphate and adding narkophin. Rothig³¹ did not advise its use because of a depression of the respiratory center and consequently a state of hypoventilation. In their monograph Anschütz, Specht and Tiemann³ state that the use of avertin in neurosurgery constitutes an important progress. Dandy¹⁶ prefers avertin to ether which he believes is associated with swelling of the brain and postoperative vomiting, a factor favoring postoperative pneumonia. He gives dosages varying from 60 to 100 mg., usually 90 to 95 mg. It is his opinion that the use of avertin is most advantageous for exposure of cerebellar

lesions, the pituitary region and other basilar areas. Goldschmidt and Hunt²³ reported 314 narcoses performed on 225 patients. In their series, there were 19 neurosurgical operations. These authors gave doses of 80 to 100 mg. per Kg. of body weight at a concentration of 2.5 per cent. In 24 per cent of their cases complete narcosis was obtained, and in 20 per cent this basal anesthesia had to be supplemented. They noted an average blood pressure fall (systolic) of 24 points and reported one case of death following a ventricular puncture where the dose of avertin used was 100 mg. per Kg. of body weight, and a total dosage of 7.3 Gm. No postmortem examination was made. Dott¹⁸ uses 100 mg. per Kg. plus omnopon and hyoscine. Field and Pilcher, in using dosages of 80 to 100 mg. plus N₂O and ether, reported a 50 per cent reduction in the number of pulmonary complications with the diminution of postoperative headaches. Hadfield²⁵ uses avertin combined with a local anesthesia, the one having a synergetic action on the other. Bogan⁸ reports using avertin in 907 cases. Of these 41 were neurosurgical cases. There were seven deaths for which the drug could not be held responsible. Wood,⁴² using a dosage of 90 mg. per Kg. plus hyoscine, reports very good results. Davidoff¹⁷ also uses 70 mg. of avertin for women and 80 mg. for men, but administers it only after local anesthesia has been given. Cushing¹⁴ has used avertin per rectum with highly satisfactory results in patients who may be intolerant of local anesthesia alone. On the contrary, Bailey⁵ is opposed to the use of avertin because of its depressing effect on the blood pressure and the nervous system, the imperfect narcosis obtained at times, and the lack of muscular relaxation. He states that the pulmonary complications in neurosurgery are rare with any anesthesia used.

Technic.—Before going over the report of our cases, we will state the technic generally used in this hospital. On the day prior to operation the patient is placed on a liquid diet. An enema is given during the evening before operation. After the patient has been brought to the operating room, the blood pressure and pulse are recorded over a short period of time. At times, particularly with children, the patient is not shaved until after the avertin has been given. The avertin is given on the division to children who are known to be fearful or apprehensive. The avertin fluid is mixed with freshly distilled water to make a 3 per cent solution, the avertin being added to the water already heated to at least 38° C. and not over 42° C. After thoroughly shaking, the solution is tested with Congo red. If a change in color is not seen (that is, if no acidity is present), the solution is given per rectum. As stated elsewhere, the dose of 70 mg. per Kg. is given in two parts when dealing with lesions of the third or fourth ventricle or in debilitated subjects. Large vigorous subjects are given morphia (Gm. 0.010–Gm. 0.015) after coming to the operating room. This also is given in divided doses at times. The patient is then watched carefully, the blood pressure and pulse being recorded every two to three minutes along with any respiratory changes. A local anesthesia is then given for the major operations. If, during the infiltration of novocaine the patient becomes restless or seems

about to awaken, ether vapor is usually given for a short time. It has been found by experience that a short ether anesthesia given soon after avertin is administered may obviate a much longer one if its administration is delayed until the patient is actually awake.

Statistical Résumé.—Two hundred and fifty consecutive anesthetics given on the neurosurgical service have been studied. Our inquiry is necessarily a clinical one and results recorded are, therefore, in part, "impressions." The degree of postoperative vomiting following the use of avertin as compared with ether is an example of this. It must also be borne in mind that this is not a study of the use of avertin alone but rather of its use in conjunction with other drugs such as morphia, ether, novocaine and at times nitrous oxide. The beneficial or deleterious effects of the avertin cannot be accurately quantitated from figures alone. Again an "impression" has to be relied upon to a certain extent. The value of avertin as an anesthetic will first be considered and then its possible relationship to mortality, morbidity, and postoperative pneumonia. We also wish to consider the relationship of avertin to alterations in pulse, blood pressure and respiration. Experience has shown that patients with lesions in certain areas respond differently to avertin and this will be commented upon.

The following points have been recorded for each case: Sex, age, diagnosis, operation, preoperative drugs, weight, dosage per Kg. of body weight, total dosage, concentration of the solution, blood pressure at various times of the operation, pulse rate changes, supplementary anesthetic, quality of the narcosis, and probable postoperative deaths.

We shall use the distinctive qualifications of adequate "surgical narcosis" which does not need to be further defined; of "sufficient narcosis" which is one under which an operation was performed without much difficulty but yet without complete surgical narcosis, and "inadequate narcosis" meaning that the avertin would have had to be supplemented by either for a major procedure.

GROUP I.—NARCOSIS WITH AVERTIN ONLY

THIRTY-FOUR CASES

	Doscs in mg. per Kg. of body weight						
	35	45	60	70	90	100	110
Surgical narcosis: 26 cases.....	1	0	0	12	8	4	1 = 26
Sufficient narcosis: 3 cases.....	0	1	0	1	1	0	0 = 3
Inadequate narcosis: 5 cases.....	0	0	1	2	2	0	0 = 5

Of the 26 cases recorded as securing a "surgical narcosis" there were only two major procedures. The remainder were for dressings, encephalograms, exploratory burr holes, resection of peripheral nerves and débridements of wounds. One of the major procedures was a craniotomy with exploration of the third ventricle (100 mg. per Kg.). The other was for an old osteomyelitis of the skull with removal of a bone flap (100 mg. per Kg. of body weight).

As shown above the dosages have varied from 35 to 110 mg. per Kg. of body weight. The majority of the cases were given 70 to 90 mg. per Kg. of body weight (26 of 34 instances).

In the same group there were three instances of "sufficient narcosis" including two minor and one major operations (removal of a third ventricle tumor, the dosage being 35 mg. per Kg. of body weight).

Finally, five narcoses were considered "inadequate" with dosages of 60, 70 and 90 mg.

In this series of 34 cases four fatalities occurred. In later discussion it will be pointed out that avertin in all probability had no part in producing these deaths.

In trying to ascertain the factors contributing to an adequate "surgical narcosis" the preoperative medication was considered. Of 26 cases of "surgical narcosis" with avertin alone, 12 did not receive any preliminary medication and 14 received either luminal or morphia or both. The majority of unsuccessful narcoses occurred when a preoperative drug was not given. In the group of narcoses secured with luminal (0.1 to 0.2 Gm.) as a preoperative drug, there were three instances of "sufficient narcosis" and one "inadequate." Where morphine was used as a preoperative drug a working narcosis was secured in all instances. The usual dose of morphia was 0.010 Gm. for an adult.

Preoperative Medication

Thirty-four Cases with Avertin Alone

	Surgical Narcosis	Sufficient Narcosis	Inadequate Narcosis	
No preoperative drugs.....	12	2	4	= 18
Luminal.....	3	1	1	= 5
Morphine (0.005 to 0.015 Gm.).....	8	0	0	= 8
Morphine plus luminal.....	3	0	0	= 3

Preoperative medication seemed to play a greater rôle in the successful use of avertin alone than the type of procedure, keeping in mind that most of the procedures were minor affairs.

GROUP II.—NARCOSES PRODUCED BY AVERTIN PLUS LOCAL ANESTHESIA

SIXTY-ONE CASES

	Doses in mg. per Kg. of Body Weight									
	30	35	45	60	70	80	90	100	110	
Surgical narcosis: 46 cases.....	1	2	0	1	18	5	15	3	1	= 46
Sufficient narcosis: 9 cases.....	0	4	0	0	3	0	1	1	0	= 9
Inadequate narcosis: 6 cases.....	0	0	0	0	5	0	1	0	0	= 6

The second group includes 61 procedures performed with avertin and local anesthesia, the latter having been given as a rule 10 to 15 minutes after the avertin had been given. Novocaine one per cent was used with addition of adrenalin (3 to 5 gtt. per 30 cc.).

Of the 61 narcoses in this group 46 have been considered "surgical" or 75 per cent. The percentage of "surgical narcosis" with avertin alone was 76 per cent. However, narcoses in this group have been used in more major procedures such as craniotomies,²⁵ subtemporal decompressions,⁴ cerebellar exposures,⁵ laminectomies,¹ and minor operations such as ventriculographies. In the same group there have been nine "sufficient narcoses." Eight of these have been for major operations. In four instances the dose was 35 mg., which might explain the lack of a "surgical narcosis." Finally, there have been six "insufficient" narcoses. In one instance the drug was expelled. In another the avertin was given in two doses some 30 minutes apart. We are unable to explain the failure to produce narcosis in the other four cases.

In this series of 61 cases 14 deaths occurred, of which one has to be related to the use of avertin; this instance will be referred to in detail in the mortality résumé.

As in the case of the group using avertin alone the quality of the narcosis seems definitely to depend upon the preoperative drugs used.

Preoperative Drugs Used with Avertin Plus Novocaine

	Surgical Narcosis	Sufficient Narcosis	Inadequate Narcosis
No preoperative drug.....	5 cases	1 case	2 cases
Morphine (0.005-0.015 Gm.).....	22 cases	5 cases	1 case
Luminal (0.1-0.2 Gm.).....	5 cases	1 case	1 case
Morphine plus luminal.....	14 cases	2 cases	2 cases
	—	—	—
	46 cases	9 cases	6 cases

Combining Group I (34 cases) and Group II (61 cases) we have 38 per cent of the total in which the use of an inhalation anesthetic was not necessary. It is quite possible that by using larger dosages of avertin the percentage of "surgical narcoses" could have been increased beyond this. However, in the reported cases with doses as high as 130 mg. per Kg. of body weight, there still remained a considerable percentage of inadequate narcoses. The risks of such increased doses are such that we feel that they are quite contra-indicated.

The administration of the local anesthesia before giving avertin undoubtedly adds to the efficacy of avertin. However, this is not practical in children or apprehensive adults. Davidoff¹⁷ and others have practiced giving avertin after the operation is well under way with novocaine anesthesia. In spite of all precautions there probably will always remain a certain percentage of cases refractory to the use of the drug alone plus novocaine. There is also surprising individual variation of the same patient to the same dosage given at different times. It has been our observation that a patient will take a lesser dose of avertin for a second stage craniotomy than a first although the factor of pain may be the same.

The remaining 155 narcoses are divided into three subgroups.

AVERTIN IN NEUROSURGERY

GROUP III.—(A) AVERTIN PLUS ETHER; (B) AVERTIN PLUS LOCAL PLUS ETHER; (C) AVERTIN PLUS N₂O PLUS O₂

ONE HUNDRED AND FIFTY-FIVE CASES

	Doses in mg. per Kg. of Body Weight						
(A) Avertin plus ether: 44 cases	35	60	70	80	90	100	
Slight amount of ether: 42 cases.....	1	3	14	5	7	12	= 42
Large amount of ether: 3 cases.....	0	0	0	0	0	2	= 2
(B) Avertin plus ether plus novocaine anesthesia: 95 cases							
Slight amount of ether: 95 cases.....	5	6	49	10	20	5	= 95
Large amount of ether: 0 cases.....	0	0	0	0	0	0	
(C) Avertin plus N ₂ O plus O ₂ : 16 cases.....	0	0	8	0	2	6	= 16
							155

These three subgroups represent to a certain extent failures of the avertin or avertin plus novocaine to produce a sufficient or surgical narcosis. However, even when the avertin failed to produce narcosis adequate for work, it did afford at least two distinct advantages. First the patients could be anesthetized with ether without the usual period of excitement or struggle. In the second place the amount of ether necessary to sustain the narcosis was markedly diminished. A large amount of ether was necessary but in two cases. It is our observation that when ether anesthesia is started shortly after the avertin has been given, the degree the blood pressure falls is less than otherwise. A short ether anesthesia is also a fairly effective means of elevating, in a measure at least, a lowered blood pressure.

Sixteen narcoses have been secured with avertin and N₂O plus O₂. This type of anesthesia has been used largely for encephalograms where it seemed more convenient to give a slight supplement of anesthetic in the form of a short N₂O narcosis rather than a complete ether anesthesia.

Preoperative drugs have been used in this group about the same as those used for the first two groups. In Group III, where ether plus avertin plus novocaine was used, there were three cases of death that were due in part at least, we feel, to the avertin.

MORTALITY RÉSUMÉ AND CRITIQUE

Among the 250 narcoses performed there have been 30 cases of death (12 per cent). These deaths may be divided into two groups. The first one includes the cases where the cause of the death is definitely without relation to the use of avertin as shown by the postoperative course or the post-mortem examination. The second group includes the cases where avertin as a cause of death, in part at least, must be definitely considered.

GROUP I.—DEATHS WITHOUT RELATION TO USE OF AVERTIN NINETEEN CASES

No. 34572—H. C., aged 20. Avertin 70 mg. (4.3 Gm.) 3 per cent solution. Luminal 0.2 Gm. 12 hours prior to operation. Morphia 0.005 Gm. just prior to use of avertin.

Ether vapor for 140 minutes. *Operation.*—Suboccipital craniotomy for acoustic neurinoma. In reflecting the dura from over the right cerebellar lobe a large anomalous vein running between the superior surface of the cerebellum and the dura was torn. In order to control this bleeding the greater part of the right cerebellar hemisphere had to be resected. The wound was then closed, leaving the tumor extirpation for the second stage. The patient died, however, some ten hours later. Autopsy gave evidence of considerable edema of the brain stem. There was a moderate-sized blood clot between the tumor and the brain stem. It was felt that death was due to the presence of blood about the brain stem, edema of the pons and medulla, and not to avertin.

No. 84661.—C. C., aged 14. Avertin 70 mg. Ether 10 to 15 minutes. *Diagnosis.*—Brain abscess suspect. *Operation.*—A burr hole exploration over the right and left cerebellar lobes was made upon a comatose patient suspected of having a brain abscess. Burr hole over the right occipital region. No evidence of an abscess was encountered. The right lateral ventricle was tapped and found to be dilated. Death occurred six days later. Postmortem examination revealed a tuberculous meningitis.

No. 12283.—A. M., aged 25. Avertin 90 mg. Morphia 0.010 Gm. *Operation.*—The posterior cistern was exposed and drained for meningitis (staphylococcus). The patient had been comatose for two to three days prior to operation. Death occurred some 24 hours after operation.

No. 86523.—S. O'C., aged 49. Avertin 70 mg. Luminal 0.2 Gm. 12 hours prior to operation. Morphia 0.010 Gm. just prior to operation for an acoustic neurinoma. Ether anesthesia for 280 minutes. *Operation.*—Subtotal enucleation of acoustic neurinoma, left. Death occurred during the latter part of the operation. A postmortem examination was not granted. It was thought that death was due to edema of the brain stem and respiratory failure.

No. 59649.—W. H., aged 4. Avertin 100 mg. Luminal 0.1 Gm. 12 hours prior to operation. Ether 180 minutes. *Operation.*—Suboccipital craniotomy for large cerebellar medulla blastoma invading brain stem. Death occurred during closure of wound. A postmortem examination was not permitted. It was felt that death was due to trauma to the pons in removing the tumor invading it rather than to the avertin.

No. 68409.—R. K., aged 6. This patient was found to have multiple metastatic pneumococcal brain abscesses mainly in the left frontal lobe. Death occurred five days after drainage of the fourth abscess from rupture of purulent material into the ventricle. Avertin anesthesia was given on four occasions. The last anesthesia consisted of avertin 100 mg. Luminal 0.015 Gm. was given 12 hours prior to operation. Death was obviously not due to avertin.

No. 91486.—B. S., aged 44. Avertin 70 mg. Luminal 0.2 Gm. 12 hours prior to operation. Ether 80 minutes. *Operation.*—Second-stage craniotomy for a very large meningioma of the right lateral ventricle arising from the choroid plexus and found to be extending out into the temporal lobe. The patient was conscious at the end of the operation, able to talk and swallow well. The next day she was also in excellent condition. During the third and fourth postoperative days the temperature rose and signs of bronchopneumonia developed. Death occurred on the sixth postoperative day. A relevation of the bone flap was done on the fifth day under local, to be certain that we were not dealing with debris in the ventricle as well as pneumonia. Postmortem examination revealed a bilateral bronchopneumonia.

No. 90913.—G. U., aged 55. Avertin 70 mg., novocaine. Morphia 0.005 Gm. *Operation.*—A simple suboccipital decompression for a far advanced acoustic neurinoma with multiple cranial nerve palsies was carried out as a first-stage procedure. A small biopsy of a very vascular tumor was made. Death occurred four days later from a bronchopneumonia—evidently from aspiration of food and secretions. Autopsy obtained.

No. 61084.—G. R. H., aged 8. Avertin 70 mg. and novocaine. Ether 20 minutes. *Operation.*—Burr hole exploration over the right lobe of the cerebellum. Ventricleulogram. Right subtemporal decompression. This patient had a long drawn out history of an infected mastoid. When seen by us he was comatose and presented the picture of a

high degree of intracranial tension. A cerebellar abscess was suspected. A burr hole exploration, however, failed to reveal the presence of an abscess. A ventriculogram showed dilated ventricles. A subtemporal decompression was done as a means of relief of intracranial tension. Death occurred four days later. No autopsy. Suspected diagnosis—inflammatory occlusion of the aqueduct of Sylvius.

No. 84161.—K. B., aged 8. Avertin 35 mg. and novocaine. *Operation.*—Craniotomy for large third ventricle tumor (astroblastoma) which had invaded the lateral ventricle. Death occurred four days later. Autopsy showed an invasion and occlusion of the aqueduct of Sylvius as well as an extensive third and lateral ventricle tumor.

No. 58889.—C. H., aged 48. Avertin 90 mg. and novocaine. *Operation.*—Drainage of brain abscess secondary to lung abscess. Death four days later. Autopsy showed a thrombosis of left middle and posterior cerebral arteries, large brain abscess and lung abscess.

No. 50399.—C. W., aged 13. Avertin 90 mg. *Operation.*—Drainage of one of several frontal lobe abscesses. Death 14 days later. Autopsy showed an extensive cerebritis and several undrained abscesses.

No. 58238.—M. F., aged 49. Avertin 85 mg., novocaine, luminal 0.2 Gm. 12 hours preoperatively. *Operation.*—Craniotomy for left temporoparietal glioblastoma in a hemiplegic individual. A large mass of tumor was removed to insure temporary relief of heightened intracranial pressure. Death occurred five days later of cerebral edema and bronchopneumonia (autopsy obtained).

No. 70056.—J. R., aged 3. Avertin 100 mg., ether 180 minutes, novocaine. *Operation.*—Extensive removal of a cerebellar medulla blastoma in a much debilitated subject. Death nine days later of lobar and bronchopneumonia. Autopsy obtained.

No. 95199.—G. S., aged 62. Avertin 70 mg. Morphine 0.010 Gm. Novocaine. *Operation.*—Craniotomy for extensive right temporoparietal oligodendroglioma in a semicomatose patient. Death occurred 17 days later. Autopsy showed a terminal bronchopneumonia and multiple small lung abscesses.

No. 96244.—D. H., aged 7. Avertin 70 mg. (partially expelled), novocaine, ether 100 minutes. *Operation.*—Subtotal enucleation of cerebellar medulloblastoma with seeding in subarachnoid bed. Death one month later from unrelieved intracranial tension. No autopsy.

No. 48809.—P. A., aged 49. Avertin 90 mg. Morphine 0.015 Gm., novocaine, ether 180 minutes. *Operation.*—Suboccipital decompression for suspected tumor. Death ten days later from staphylococcus meningitis (wound infection). Autopsy showed a small cystic pineal tumor.

No. 60763.—Z. M., aged 37. Avertin 75 mg., novocaine. *Operation.*—Second-stage operation for a temporal lobe meningioma. Death 14 days later from erysipelas of head, neck and trunk. Autopsy showed evidence of meningitis of a few hours' duration.

No. 82203.—A. G., aged 32. Avertin 50 mg., novocaine. Morphine 0.015 Gm. *Operation.*—Craniotomy for third ventricle tumor which was found to be invading the left frontal lobe also. Death 11 days later. Autopsy showed an extensive third ventricle tumor invading each frontal lobe. An internal hydrocephalus and cerebral edema was also noted at autopsy.

The cause of death in these 19 cases would seem to be due to other factors than the avertin. The majority of those patients died several days after the operative procedure. However, it seems worthy of comment that five (91486, 90913, 58238, 70056, 95199) deaths occurred with respiratory complications. In only one (91486), however, does it seem that the bronchopneumonia could be related to anesthesia (0.004 per cent for the entire series of 250 cases). The other four patients were either semicomatose on admission or presented difficulties in swallowing that might be followed by pneu-

monia regardless of an anesthetic. If one chooses to include all five cases in the list of postoperative pulmonary complications the percentage is 2 per cent.

The second group of fatal cases, 11 in number, will be reviewed with particular reference to the relationship of avertin to the cause of death.

GROUP II.—DEATHS HAVING A POSSIBLE RELATION TO USE OF AVERTIN
ELEVEN CASES

No. 81798.—D. L. J., male, aged 49. This patient was semicomatose at the start of a transfrontal craniotomy performed for the removal of an extensive extrasellar pituitary adenoma. Novocaine anesthesia having been inadequate for work, 2.9 Gm. of avertin (35 mg. per Kg. of body weight) (3 per cent) were given. A surgical narcosis was obtained; the patient did not recover consciousness following the operation and died after 18 hours. The postmortem examination revealed a chronic endocarditis with pulmonary embolism and infarction. The remaining pituitary adenoma was a large one extending well back into the interpeduncular region—compressing the upper pons. That avertin was a major contributing cause of death seems doubtful.

No. 50643.—F. P., male, aged 38. This patient was operated upon for the second time in four months for a very malignant type of meningioblastoma in the right frontal region. He died seven hours after avertin and novocaine anesthesia had been given (70 mg.) and one and a half hours after the completion of the operation. A marked drop in blood pressure occurred twice during the operation, necessitating two transfusions, the second of which did not have any effect on the pressure. A fall in blood pressure did not follow directly upon administering avertin. Preoperative medication consisted of sodium amytal 0.2 Gm. and codein 0.030 Gm. The cause of death in this case was undoubtedly due to a combination of an extensive invasive tumor, hemorrhage and the trauma of operation rather than avertin.

No. 59426.—C. MacV., female, aged 9. This patient was originally operated on in this clinic in April, 1932, for a cystic pituitary gland. It was thought that the cyst was traumatic in origin since all symptoms, ocular and metabolic, followed a fracture of the skull. A good deal of relief of headache and visual symptoms followed the evacuation of 12 to 15 cc. of fluid from the cyst. A violent wave of hyperthermia followed operation, during which the patient nearly succumbed.

Symptoms recurred by January, 1934. At a second operation the cyst was readily emptied again. Avertin 35 mg. per Kg. was used plus ether and novocaine anesthesia. Blood pressure dropped from 90 Mm. Hg. to 45 Mm. Hg. as the cyst was being emptied. Another severe wave of hyperthermia followed. Death occurred some seven hours after operation.

We cannot say that avertin may not have had a part in the production of hyperthermia. However, this seems unlikely. Untoward symptoms came on immediately after emptying the cyst. Avertin was given at the time of the first operation in 1932, but was expelled before any effect was noted. Ether and novocaine alone were therefore used at that time. A wave of hyperthermia followed. It would seem more likely that death occurred from a disturbance of hypothalamic functions associated with emptying the cyst rather than the avertin.

No. 51239.—H. M., female, aged 50. This patient was operated on for a large left olfactory groove meningioma. During the course of the operation the left anterior cerebral artery was injured. Death occurred eight hours after completion of the operation. The patient was given avertin (90 mg. per Kg. of body weight) which was partly expelled. No preoperative drugs were used. Ether vapor was used for 270 minutes as a supplement to avertin and novocaine. A postmortem examination showed an embolus in the left pulmonary artery coming from thrombi in the pelvic plexus. It also showed a clot about the hypothalamic region in the subdural space which was probably the chief cause of death.

No. 77103.—F. L., female, aged 43, was operated upon for a rather extensive tumor

of the right frontal lobe invading the corpus callosum. Avertin (70 mg. per Kg. of body weight) (3 per cent) was given without preoperative drugs. Ether narcosis was started before the anesthesia from avertin was complete and was given during 180 minutes out of 260. A severe drop of blood pressure occurred after 180 minutes. There had been but little loss of blood. The fall of blood pressure following the administration of avertin was 25 Mm. Hg. after 20 minutes and 40 Mm. Hg. after 60 minutes. Blood pressure returned to its previous value after 110 minutes. The patient remained semi-comatose for 48 hours and on the third postoperative day died with high temperature.

In this case the exact cause of death is uncertain. The tumor was an extensive one involving the corpus callosum. Postmortem examination showed a rather extensive cerebral edema.

No. 74022.—M. M., female, aged 2, presented a huge ependymoma of the left parietal region extending across the middle line into the right ventricle. This tumor was partly removed in a first stage operation following which, however, signs of increased intracranial pressure were not relieved and a second procedure was undertaken. Avertin (80 mg. Kg. per body weight) was given. A portion of the dose was expelled and anesthesia did not follow. 30 mg. per Kg. was then given in a second dose. Again no anesth sia resulted. Ether anesthesia was then given. The rate of the pulse and of the respiration increased rapidly. Cheyne-Stokes' type of respiration appeared. Death occurred 160 minutes after the beginning of the operation. Autopsy showed a tumor arising from the choroid plexus which had crossed the midline and was invading the opposite hemisphere. This picture does not correspond at all with what we know about avertin intoxication. Since the use of avertin did not produce even a light sleep it is doubtful if it could be a factor in this case.

No. 51656.—M. R., female, aged 43. This patient was operated upon for an acoustic neurinoma with a very satisfactory subtotal removal. Avertin 5.1 Gm. (100 mg. per Kg., 3 per cent) was given. Preoperative medication consisted of 0.10 Gm. luminal and 0.010 Gm. of morphine. A good narcosis was produced and ether was not necessary. Blood pressure fell slowly during operation from 110/80 to 75/60. Half an hour after the completion of the operation a severe fall of blood pressure occurred. A transfusion of 250 cc. of blood was given with a return of blood pressure to 100 Mm. of Hg. The patient was rather slow to regain consciousness but 36 hours after the operation was talking and taking fluids well. On the third day she became comatose and died on the fourth day with respiratory troubles (Cheyne-Stokes) and final respiratory failure. From inspection of the wound and lumbar puncture it did not seem likely that bleeding was a factor. A postmortem examination was not obtained and the exact cause of death is not known.

No. 42194.—J. H., male, aged 59. This patient died 20 hours after a craniotomy for an extensive right posterior temporal lobe glioma. He was given avertin (80 mg. per Kg.) and morphine 0.010 Gm. at 8:15 A.M. Only a slight narcosis resulted. The bone flap was turned down under novocaine anesthesia. Another 0.010 Gm. of morphine was then given, followed by ether vapor for 30 minutes while the tumor was being resected. He did not regain consciousness following the operation. Death occurred 20 hours later. The postmortem examination failed to disclose the cause of death. We believe it may have been associated with clipping the posterior cerebral artery. It is rather difficult to rule out the possibility of a correlation between the use of avertin and death in spite of the light narcosis produced by it.

No. 57105.—P. R., female, aged 17. This patient developed a marked hydrocephalus on the basis of a sarcomatosis of the meninges. A simple suboccipital decompression was performed following which the patient did fairly well for several hours. Death occurred from a sudden respiratory failure some five hours after operation. A postmortem examination failed to disclose any gross bleeding. A sarcomatosis of the meninges was demonstrated. Avertin was given (80 mg. per Kg., 3 per cent). No preoperative drugs were used. Ether vapor was necessary during the whole procedure, the avertin having pro-

duced an incomplete narcosis. The fact that the narcosis was incomplete and that the patient reacted after the operation seem to speak against a correlation between the avertin narcosis and death. On the other hand, as the death occurred in a rather short time after the operation with prevailing respiratory difficulty, it prevents us from ruling out the avertin as a contributing cause of death, especially since autopsy failed to show any other cause. Patients with sarcomatosis of the meninges, however, frequently suffer difficulties of respiration.

No. 61624.—J. R., male, aged 14. This patient was operated upon for a cerebellar medulloblastoma. Avertin (90 mg. per Kg., 3 per cent) was given. Preoperative drugs consisted in 0.09 Gm. of luminal 12 hours before operation. Morphia 0.008 Gm. was given shortly before the avertin and again as closure of the wound was started because of restlessness. Ether was not necessary. Novocaine was used as usual. During the operation respiration ceased twice. The pulse and the blood pressure, however, remained unchanged. Those incidents occurred while dealing with that part of the tumor closely associated with the medulla. During the five hours following the operation the respiration became progressively more difficult without corresponding changes in the blood pressure and pulse until shortly before death. A postmortem examination was not allowed. However, from operative findings we believe that the floor of the fourth ventricle was invaded by tumor. This plus the operative trauma was probably the chief cause of death, although the use of avertin cannot be entirely ruled out. It was also felt that he may have had too much morphine even though he was large for his age.

No. 92248.—C. McJ., male, aged 15. The last patient presented clinical signs of a cerebellar abscess. In order to verify this diagnosis an exploratory burr hole was made under local anesthesia over the right suboccipital region. The right lobe of the cerebellum was tapped three times without encountering an abscess. A cerebellar exposure was decided upon and started. Avertin (70 mg. per Kg., 3 per cent) was given producing a slight degree of narcosis. Luminal 0.1 Gm. had been given 12 hours previously. Ether was started 10 minutes after the avertin was given. The patient became cyanotic, the respiration irregular, the pulse rapid and the blood pressure rose from 135/80 to 150/80. The skin incision was closed. Oxygen was given with beneficial results. Respirations became rapid, and irregular. The pulse ranged from 130 to 150. Some 230 minutes after the avertin had been given the respiration ceased. The postmortem examination showed the presence of a marked leukocytic infiltration of the right half of the pons and the medulla oblongata. There were also small foci of necrosis and hemorrhage noted.

In this case we have undoubtedly to deal with an "avertin death." Respiratory difficulty began about 15 minutes after the drug had been given and continued until time of death some four hours later. The dose of avertin was small. However, it was probably too large in the light of the postmortem finding of an already embarrassed brain stem.

In summarizing the findings of this second group of patients we can say that the first seven cases died in all probability from causes other than the avertin narcosis. In the last four cases, however, it seems that the avertin may have been one of the factors in the cause of death. A résumé of these four cases is of interest.

In the first three of them there was an increase of pulse rate of ten beats per minute after the avertin was given. The above table seems to put two points in evidence: first, in three times out of four cases the lesion was located in the posterior fossa. Secondly, in two cases morphine was given twice during operation. Thirdly, the changes in the blood pressure were small and seemingly of little note as were changes in pulse rate. The percentage of fatalities relative to the use of avertin is 1.6 per cent, or four

SUMMARY OF LAST FOUR FATALITIES

Unit No.	Name	Age	Sex	Location of Tumor	Operation	Preop. Drugs	Dosage mg.	Dosage Total	Concentration	Blood Press. Fall	Ether	Novo-caine 1%
42194	J. H.	59	M.	Rt. post. temp. lobe glioma	Craniotomy with subtotal removal of tumor	Morphine 0.010 Gm. twice	80 mg.	4.3 Gm.	3%	15 points after 10 min.	Yes	Yes
57105	P. R.	17	F.	Sarcomatosis of meninges	Suboccipital decompression	None	80 mg.	3.3 Gm.	3%	No fall	Yes	No
61624	J. R.	14	M.	Cerebellar medulloblastoma	Subtotal removal of tumor	Luminal 0.097 Gm. Morphine 0.008 Gm. twice	90 mg.	2.9 Gm.	3%	10 points after 20 min.	No	Yes
92248	C. McJ.	15	M.	Leukocytic infiltration of medulla	Exploratory burr holes	Luminal 0.1 Gm.	70 mg.	2.8 Gm.	3%	No fall	No	Yes

cases out of 250 narcoses. This is assuming that avertin played a major part in the fatality. In only one case, No. 92248, do we feel that this is entirely true (0.004 per cent). The mortality rate for the series of the 250 cases is 30 cases or 12 per cent.

The question of the relationship of avertin effect to location of the tumor has been considered. While the exact site of action of avertin may not be known, there is ample proof that it does act on the hypothalamus. White and Van Wagenen have also shown experimentally that it also acts on the brain stem. They likewise have evidence to show that the action of avertin on an injured brain or after resections of portions of the brain is greater than otherwise. A theory is postulated that where the function of the hypothalamus or brain stem is embarrassed by the presence of a tumor, the avertin effect on the intact portion is greater than otherwise and the clinical effects to be noted are more pronounced. It would therefore seem reasonable to argue that lesser doses of the drug are indicated where one is dealing with an embarrassed hypothalamic region or brain stem.

A review of our cases supports this theory. Among 54 tumors involving or neighboring on these structures the mortality was 22 plus per cent as compared with 12 plus per cent for the group as a whole. A part of this increase in mortality is undoubtedly associated with the location of the lesion, its extent, duration, and general condition of the patient. However, it is seen from the accompanying table that most of the deaths (10 out of 12) occurred when the higher dosages of avertin were used (70 to 100 mg. per Kg. of body weight). We feel that when lesions in or about the third or fourth ventricle are being attacked a preliminary dosage of 35 mg. of avertin per Kg. body weight is sufficient. Another 35 mg. may be given later if indicated.

LESIONS OF THIRD AND FOURTH VENTRICLES AND ADJOINING REGIONS WITH MORTALITY FIGURES AND AVERTIN DOSAGE

FIFTY-FOUR CASES

Location of the Lesion	Dosage of Avertin in mg.						
	35	45	50	70	80	90	100
Cerebellum, 21 cases.....	1	1	0	9	2	5	3
Deaths, 4 cases.....	0	0	0	1	0	1	2
Nervus acusticus, 10 cases.....	0	0	1	4	0	2	3
Deaths, 4 cases.....	0	0	0	3	0	0	1
Third ventricle, 8 cases.....	1	0	1	0	1	4	1
Death, 1 case.....	0	0	0	0	0	1	0
Fourth ventricle, 3 cases.....	0	0	0	1	0	0	2
Deaths, 0.....	0	0	0	0	0	0	0
Pituitary body, 10 cases.....	7	0	0	1	0	2	0
Deaths, 2 cases.....	2	0	0	0	0	0	0
Pons, 2 cases.....	0	0	0	1	1	0	0
Death, 1 case.....	0	0	0	1	0	0	0

DEGREE OF NARCOSIS OBTAINED BY USE OF AVERTIN IN LESIONS OF THE BRAIN STEM
AND HYPOTHALAMIC REGION

FIFTY-FOUR CASES

Tumor Site	Dosage	Surgical Narcosis.		Adequate Narcosis	Insufficient Narcosis
		Ether	Unnecessary		
Pituitary body.....	35	0		4	3
	70	0		1	0
	90	0		2	0
Cerebellum.....	35	1		0	0
	45	0		1	0
	70	2		4	3
	80-100	3		5	2
Nervus acousticus.....	50	0		0	1
	70	1		3	0
	80-100	1		3	1
Third ventricle.....	35	0		1	0
	50	0		1	0
	80-100	1		3	2
Fourth ventricle.....	70	0		1	0
	100	0		2	0
Pons.....	70	0		1	0
	80	0		1	0
		—		—	—
		9		33	12 = 54

The percentage of surgical and adequate narcoses obtained by the use of avertin in this group of cases is considerably higher than for the series as a whole. The percentage for this group of brain stem and hypothalamic lesions is 77 per cent. For the series as a whole it is 37 per cent—95 out of 250 cases.

If one groups the pituitary and third ventricle tumors together (18 cases) there are 13 instances of surgical and adequate narcoses observed, or 66 per cent. Grouping the lesions of the cerebellum, nervus acousticus, fourth ventricle and pons together (36 cases) there are 29 instances of surgical and adequate narcoses. In other words, avertin has a greater effect in producing narcosis when there is a lesion of the hypothalamic region or in the posterior fossa than it does for a group of heterogeneous lesions of the nervous system.

Changes in the Blood Pressure Associated with the Use of Avertin.—The inquiry regarding the changes of the blood pressure in our series concerns 232 anesthetics. We may divide them into two groups. In Group I are the cases where a fall of blood pressure did not occur or where it might even have been increased. In Group II are the cases in which a fall in the blood pressure did occur.

There are 59 cases in the first group (24.5 per cent). The percentage of patients obtaining narcosis without a fall in blood pressure is 55.9 per cent (33 cases). The percentage securing adequate narcosis is 28.8 per cent (17

cases). The percentage in which the avertin did not have any effect is 15.2 per cent (19 cases). If the two last groups are added together (26 cases) we note that there were 15 children (57.6 per cent).

The second group includes 173 cases. The degree of blood pressure fall following the administration of avertin is charted as follows:

Blood pressure fall of 10-20 points Hg.—62 cases—35.8%
20-30 points Hg.—60 cases—34.6%
30-40 points Hg.—24 cases—13.8%
40-50 points Hg.—10 cases— 5.6%
50-70 points Hg.—17 cases— 9.8%

The fall of the blood pressure usually takes place during the first 20 or 30 minutes after administration of the drug, starting most frequently before the lapse of ten minutes and rather quickly reaching its maximum. However, in a few cases we did observe a fall of blood pressure coming on after some 40 to 60 minutes and not related to bleeding. In a few other cases the blood pressure fell more or less progressively to a degree where administration of ephedrine or similar drugs seemed indicated. As a rule the blood pressure tends to gradually rise again after reaching its low point rather than to remain on a low plateau. Occasionally it regains its former level in about the same length of time it took to fall. These observations are true in those instances where a supplementary ether was not necessary as well as others. The use of adrenalin in the novocaine might explain a part of this curve although it has been observed where avertin alone has been used.

The 17 cases presenting the most marked falls in blood pressure—over 50 Mm. Hg.—are worthy of note. Eight of these were known to have abnormally high blood pressures to start with. Three were in individuals with moderately advanced arteriosclerosis and four were in individuals much debilitated and dehydrated.

While a precipitant drop in blood pressure may be alarming to the operator, we have never seen a fatality result from it. Operative procedures have been postponed because of it in one case (resection of the fifth nerve via extracerebellar route). In four instances an injection of ephedrine 0.050 Gm. subcutaneously was given, whereas in the remaining 13 cases the blood pressure returned to normal spontaneously.

Changes in the Pulse Rate Associated with Use of Avertin.—Two hundred forty anesthetics have been studied from this standpoint. In 84 there was noted an increase of the pulse rate of at least 10 points. In 53 cases a rise of 20 points was noted. This occurred during the 10 to 30 minutes following the introduction of the avertin. Together these two groups comprised 57 per cent of the total number. Twenty other cases presented an increase of 30 points in the same period of time. Curiously enough, these changes in pulse do not correspond as a rule with the variations of blood pressure mentioned previously. Many patients experienced both increased blood pressure and pulse rates simultaneously. Finally, 21 patients presented an increase of pulse rate of 40 points or more. The increase of pulse rate rarely amounted to 60 points and rarely occurred simultaneously with a marked fall of the blood pressure as one might expect. Changes in pulse

rate have been noted mostly in children (about 60 per cent) and also most often in cases of cerebellar tumor. The pulse rate of 16 patients did not change at all. Twenty-seven showed a fall of 10 to 20 points. This occurred simultaneously with an increasing of the blood pressure as a rule.

Finally, it is worthy of note that many patients did not present the same changes of pulse rate at the time of subsequent anesthesia even though performed under the same conditions.

Respiratory Changes Associated with Use of Avertin.—The frequency of the respiration was usually slightly increased following administration of this drug. An almost constant phenomenon is the decrease in the depth of respiration. This is seen to appear simultaneously with the appearance of a slight cyanosis which is quite typical for the avertin. The shallowness of respiration at times prolongs the induction period of ether narcosis.

SUMMARY

The ideal anesthetic for neurosurgical operations is probably novocaine. However, there are a considerable number of instances where novocaine alone can not be used. In these cases the use of avertin (tri-brom-ethanol), supplemented with ether when necessary, is of real value. The use of this drug decreases quite materially the amount of ether necessary. The swelling of brain associated with crying or struggling or coughing is largely obviated. Capillary bleeding is lessened with the fall in blood pressure that often accompanies its use. The lessened swelling of the brain associated with the diminished amount of ether used allows a more unhampered exposure of various regions of the brain, particularly the regions of the base of the skull.

There are certain cautions, however, which may well be heeded in the use of avertin. Whenever the functions of centers in the brain stem are embarrassed by the presence of a tumor a lessened dose of the drug seems indicated. Our practice has been to give 35 mg. per Kg. of body weight in such cases and follow this in 20 minutes by a similar dose if necessary. The same caution holds, but to a lesser degree, where the tumor is situated in or about the third ventricle. It has also been our experience that avertin has a greater effect upon the injured nervous system than otherwise, and consequently a lessened dosage may be in order. This also holds for certain secondary craniotomies where portions of the brain have been resected at a first stage operation.

In the series of 250 anesthetics, 34 operations were performed under avertin alone. Most of these operations were of a minor nature. Sixty-one operations of a major nature were performed under novocaine plus avertin anesthesia. Groups I and II comprise 38 per cent of the total. One hundred fifty-five cases required the use of ether or nitrous oxide anesthesia plus novocaine and avertin. The use of morphia as a preanesthetic drug seemed to be the most important factor in assuring a physiologic effect of the drug. Pain will very often counteract the effect of ordinary doses of the drug. This is seen in instances of trifacial neuralgia or severe headache.

There were 30 deaths in the 250 cases. Of these one was considered definitely as due to avertin. Three others were considered as possibly having

at least some part in the cause of death. Three of these four cases had posterior fossa lesions. In two of the four cases two doses of morphia were given instead of the usual one. There were five cases in which pulmonary complications were of serious nature. In only one case, however, does it seem that this complication was related to anesthesia.

Alterations in pulse, respiration, and blood pressure following administration of the drug occur in a considerable number of cases. However, an operation had to be delayed in only one case because of these factors. A fall of blood pressure usually is accompanied by a satisfactory physiologic effect.

While we cannot give figures to show that the number of instances of postoperative vomiting are less than after a similar number of ether anesthetics, it is our very distinct impression that this is so.

The dose of avertin considered as optimum for neurosurgical operations is 70 to 90 mg. per Kg. of body weight. This may well be preceded by a five to ten mg. of morphia.

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TUMORS OF THE CAROTID BODY*

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TUMORS of the carotid body are rare, their diagnosis is difficult, and certain pathologic problems are unsettled. The surgical extirpation of these growths is always a delicate operation, never exactly easy, while often it assumes most formidable proportions. The postoperative mortality is high and the postoperative morbidity is considerable.

That such tumors are uncommon is shown by the fact that a cursory review of the literature reveals only 230 cases. It is probable, however, that others have been overlooked or have not been reported. Bevan makes the statement that few surgeons have operated upon more than one, not many have operated upon two, and no surgeon has operated upon more than three cases. The records of some of our metropolitan hospitals show how infrequently this condition is encountered: Manhattan Eye, Ear and Throat Hospital, one case; Mount Sinai Hospital, two cases; New York Hospital, two cases; Post-Graduate Hospital, five cases; Presbyterian Hospital, two cases; St. Luke's Hospital, two cases; St. Vincent's Hospital, two cases; Babies', Bellevue, Knickerbocker, Lenox Hill, Memorial, Nursery and Child's and Roosevelt Hospitals, no cases.

Historically, it is of interest to note that the first anatomic description of the carotid body was made by Von Haller, in 1743; that Luschka gave the first microscopic picture of its structure, in 1862; that Marchand described the first recognized tumor of the carotid body, operated upon by Reigner, in 1880; and that Middleton, in 1895, was the first American surgeon to operate upon a case. Scattered throughout the literature are isolated case reports. Keen and Funke, in 1906, and Bevan and McCarthy, in 1929, published admirable articles on this subject, with complete surveys of the literature. Another interesting contribution was that of Rankin and Wellbrock, in 1931, with a record of 12 cases, from the Mayo Clinic, the largest group ever reported from a single institution.

As no one surgeon, radiologist, or pathologist has, from his own experience, encountered a sufficient number of cases of carotid body tumors to be able to offer authoritative advice on the subject of their general management, it seemed that the study of a group of cases, even though it is not large, might be profitable. An effort has been made to put on record all the cases operated upon by members of the New York Surgical Society, and incidentally, to include the cases seen at the New York Post-Graduate Hospital,

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where this study was made. We have been able to collect 18 cases for this report.

CASE REPORTS FROM MEMBERS OF THE NEW YORK SURGICAL SOCIETY

CASE I.—Dr. Howard Lilienthal, 1906. Female, aged 38 years, had a tumor ten months. First operation was only a biopsy; later one-half of tumor was removed. No clinical diagnosis was made but the pathologic diagnosis was perithelial hemangioma. The growth recurred but there were no metastases. Death took place nine months later from repeated hemorrhage and cachexia.

CASE II.—Dr. William B. Coley, 1906. Male, aged 53 years, had a tumor six years. The facial nerve was ligated. The pathologic diagnosis was mixed cell sarcoma of the carotid gland. Patient recovered from operation but died from recurrence in eight months.

CASE III.—Drs. William B. Coley and William A. Downes, 1909. Male, aged 35 years, had a tumor four months. The external carotid and some branches were ligated. The pathologic diagnosis was malignant carotid gland tumor. There was a prompt recurrence and death occurred in four months.

CASE IV.—Dr. John Douglas, 1909. Female, aged 23 years. No arteries or nerves were injured. A clinical diagnosis of tuberculous adenitis was made but pathologic examination showed perithelioma. Patient recovered but had a temporary paralysis of the vocal cord.

CASE V.—Dr. Howard Lilienthal, 1909. Female, aged 56 years, had a tumor 30 years. All carotids and the internal jugular were ligated. Clinical diagnosis was carotid tumor. The pathologic diagnosis was malignant perithelial hemangioma. Patient had a temporary aphasia and hemiplegia. She was cachectic for three years and death occurred four years after operation.

CASE VI.—Dr. Frank Mathews, 1911. Male, aged 25 years, had a tumor three years. The external jugular vein was ligated. No clinical diagnosis was made but the operative diagnosis was carotid tumor. The pathologic diagnosis also was carotid body tumor (Callison). The growth was not removed, as it would have necessitated the ligation of the common carotid artery. Patient alive in 1914. Died about a year later, the "process having traveled upward toward the base of the skull." In a communication from Doctor Mathews, of August 27, 1935, he says that "this is my only carotid body tumor which has proven really actively and clinically malignant."

CASE VII.—Dr. W. S. Schley, 1916. Male, aged 37 years, had a tumor 20 years. All carotids were ligated but no nerves were injured. No clinical diagnosis was made but the pathologic diagnosis was carotid gland tumor. Patient recovered but there was temporary hoarseness.

CASE VIII.—Dr. Joseph Wiener, 1918. Female, aged 37 years, had tumor eight years. All carotids and internal jugular were ligated. No clinical diagnosis was made but pathologic diagnosis was perithelioma of the carotid gland. Tumor was considered to be malignant. Patient recovered. Had a partial right hemiplegia, right facial paresis, and also paralysis of vocal cord. She was given roentgen ray treatment after operation. No recurrence was noted four months later. Doctor Wiener states in a recent communication that the patient was lost sight of, so the final result cannot be given.

CASE IX.—Dr. Franz Torek, 1921. Female, aged 49 years. Tumor present for five years. Clinical diagnosis, aneurysm. Operative diagnosis, carotid body tumor. The internal jugular vein was resected. Carotid vessels not ligated in removing growth. Morbidity: Slight adductor paralysis which lasted three months. Patient recovered and remained well.

CASE X.—Dr. Charles E. Farr, June, 1923. Female, aged 27 years, had tumor for three or four years. Clinical diagnosis, tuberculous node; pathologic diagnosis, perithelioma of carotid gland, of low grade malignancy. Operation was difficult and

bloody. The carotid vessels did not have to be ligated. Recovery was uneventful. Patient received roentgen ray treatment and remained well for several years, and then was lost track of.

CASE XI.—Dr. Frank Mathews, March, 1928. Male, aged 45 years. Clinical diagnosis, not given; pathologic diagnosis, tumor of the carotid body. The removal of the growth was incomplete and fragmentary, because of unwillingness to perform a carotid ligation. The tumor has slowly enlarged and is now the size of a walnut, but the patient is quite well.

CASE XII.—Dr. Edward W. Peterson. Female, aged 27 years, entered the Post-Graduate Hospital September 30, 1929. She had a tumor about the size of an English walnut, which had been present for six years. It was situated on the right side, under the sternocleidomastoid muscle, in the upper anterior cervical triangle. It was a small nodule for over five years, but between April and September it grew rapidly. It was painless and could be moved from side to side, but not up and down. Pulsation was not at all marked. There were no other symptoms except the increasing deformity caused by the growth. The clinical diagnosis was carotid body tumor, and the rapid growth suggested possible malignant change; the pathologic diagnosis was malignant perithelioma of the carotid gland. At operation October 1, 1929, the tumor was found to saddle and envelop the common carotid artery and its external and internal branches completely. A painstaking effort was made to dissect the growth from the carotids, but during the attempt, hemorrhage so profuse and uncontrollable from the substance of the tumor was encountered that it became necessary to ligate the common carotid artery. The operation was completed without further difficulty. Six hours later the patient appeared to be reacting normally. Four hours later, however, she developed a complete hemiplegia of the left side.

Two months later the physical examination showed a complete left hemiplegia, following operation for the removal of a malignant carotid body tumor. Increased hyperreflexia, left greater than right. Bilateral Babinski. Unilateral (left) Hoffman. Questionable impairment of light touch, pain and joint-muscle sense. Asteriognosis, left. Bone conduction referred to right. Tongue protrudes to left. Fundi normal. Emotional reaction—irritable, defensive, suspicious. Cooperates poorly. *Orthopedic Diagnosis.*—(1) Wrist drop, left; paralysis of arm (?) complete. (2) Equinovarus, left foot; paralysis of muscles below knee. At present the patient's general health is excellent. She walks with the aid of a cane. Her left arm is still practically useless. There has been no recurrence of the growth.

CASE XIII.—Dr. John M. Hanford, December, 1931. Male, aged 26 years, with history of tumor of left side of neck of four years' duration. Clinical diagnosis, tuberculosis of the upper deep cervical nodes. Pathologic diagnosis, paraganglioma of the carotid body. External carotid artery ligated. No nerve injury. Prompt recovery and patient has remained well.

CASE XIV.—Dr. John M. Hanford, September, 1934. Male, aged 26 years. Tumor in left side of neck for two years. Clinical diagnosis, tuberculous lymph nodes. Pathologic diagnosis, paraganglioma of the carotid body, not thought to be malignant. At operation the tumor so surrounded the carotid vessels that all three carotid vessels had to be ligated in order to remove it. The left hypoglossal nerve was divided, but reunited. After operation there was no brain damage—"probably because there had occurred a very gradual compression of the carotid arteries by the tumor." There was partial tongue paralysis and also trapezius muscle paralysis, due to spinal accessory nerve trauma during the operation. Follow up by letter, September, 1935, finds the patient in good condition.

CASE XV.—Dr. Edward W. Peterson. Female, aged 47 years, entered the Post-Graduate Hospital, May, 1935. She had had a tumor in the upper left anterior triangle of the neck for eight years. A tonsillectomy operation four years before had no effect

on the growth. In 1932, she was operated upon for a tuberculous anal fistula. In 1933, an unsuccessful attempt was made by another surgeon to remove the neck growth—the operation being stopped before the tumor was actually uncovered and its location and character determined. At the time of admission to the hospital she did not complain of any symptoms due to the presence of the neck tumor. It was quite noticeable, how-



FIG. 1A.—(Path. 63892, Doctor Peterson's second case) "Potato tumor." X.I. (enlarged $\frac{1}{2}$).

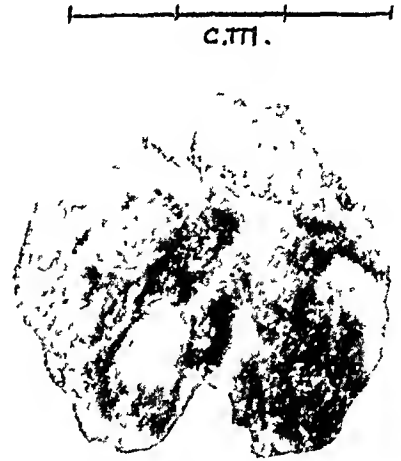


FIG. 1B.—(Path. 24746, Doctor Sheehan) Tumor removed from parotid region. X.I. (enlarged $\frac{1}{2}$).

ever, and she wished to have this deformity remedied. It was rather fixed from the previous operation, and showed slight lateral mobility, but none up and down. There was pulsation, but it was not striking. The clinical diagnosis was tuberculous nodes. At operation, as soon as the skin and platysma had been incised, a plexiform mass of vessels large and small was encountered. At this stage, it was thought that we were



FIG. 2A.—(Path. 63892.) The cut surfaces are similar. X.I.

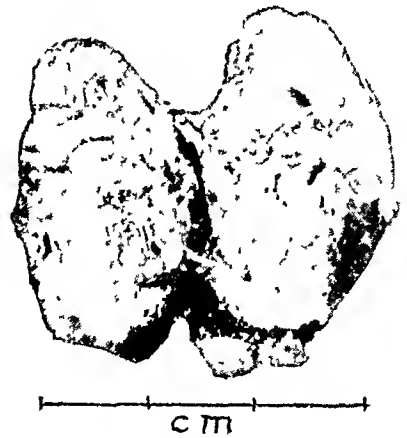


FIG. 2B.—(Path. 24746.) The cut surfaces are similar. X.I.

dealing with an angiomatous mass, around a carotid aneurysm. It was necessary to ligate a great many vessels before the actual tumor was uncovered and recognized as originating in the carotid body. The operation throughout was a delicate and most difficult one. The tumor so involved the common carotid below the bifurcation that this vessel was isolated and a tape placed around it. In view of the disastrous train of symptoms that had followed ligation in our other case, it was determined to abandon the operation rather than to subject the patient to this risk. The tumor was dis-

sected from the common carotid artery. It was found necessary to ligate the external vessel in order to mobilize the growth. Then followed a most careful dissection of the internal carotid artery. This was accomplished and the tumor removed. At two points, however, where vessels were apparently given off from the internal carotid to the carotid gland, there were wounds of this vessel. An attempt to repair this damage with fine Chinese silk left us so much in fear of secondary hemorrhage that the common carotid artery was ligated. Fortunately, there followed no evidence of brain damage, and the patient made a good recovery. There was temporary hoarseness, drooping at the left angle of the mouth, and some interference with motion in the left side of the tongue, but these evidences of nerve damage cleared up rapidly. The patient is now quite well.

Pathologic Report (63892).—Dr. W. J. MacNeal.—*Gross*.—Specimen measures 51 by 36 by 27 Mm. On section it presents a well defined capsule about 1/2 Mm. in thickness. Internal to this there is firm, slightly opaque fleshy tissue which is light pink in color where it has not been fixed. The appearance suggests altered thyroid gland (Figs. 1A and 2A).

Microscopic.—Sections show a rather thin fibrous capsule from which slender strands extend into the interior. These carry fairly large blood vessels but there are also some rather broad bands of connective tissue. The remaining mass is made up of irregular nests of polyhedral cells (Fig. 5). These cells have round or oval nuclei which are somewhat variable in size and in intensity of staining. The cells themselves are fairly large, the cytoplasm stains pink with eosin and presents a finely granular appearance (Fig. 6). The cells are variable in form. About these cell nests there are irregular blood spaces and capillaries which are in some places widely distended. There are also spindle shaped fibroblasts which appear to participate in the growth. In many places the tissue is poorly fixed and the cell nests are partly disintegrated. The mass is highly vascular everywhere. *Diagnosis*.—Tumor of the carotid body ("perithelioma of the carotid gland"). Note: These tumors are of rather slow growth, and although they may recur locally and even invade adjacent lymph nodes, they do not tend to form distant metastases.

OTHER CASES FROM THE NEW YORK POST-GRADUATE HOSPITAL

CASE A.—Dr. Neal Macphater, 1903. Female, aged 34 years, had a tumor of neck for six years. No clinical diagnosis was made; operative diagnosis, carotid body tumor; no pathologic examination was made, so the type of tumor was not determined. All carotids and internal jugular vein were ligated. Recovery without evidence of cerebral anemia or other complications.

CASE B.—Doctors Cahill and Taylor, 1916. Female, aged 52 years, had a neck tumor for eight years. No symptoms of any moment. No preoperative clinical diagnosis; pathologic diagnosis, tumor of the carotid body. Not necessary to ligate any carotid vessels, but the internal jugular vein had to be resected. Hypoglossal nerve stretched and somewhat traumatized. Temporary paralysis of tongue and dysphagia developed. Complete recovery.

CASE C.—Doctors Sheehan and Rabiner, 1925 (Figs. 1B and 2B). Female, aged 50 years, had tumor two years. No major ligations required. Clinical diagnosis, aneurysm of the facial artery. Pathologic diagnosis, carotid body tumor. Temporary paralysis of submaxillary branch of facial nerve (drooping of angle of mouth), and temporary drooping of upper eyelid. Patient was given roentgen ray treatment after operation. Good recovery.

ANALYSIS OF CASES

There were 11 females and seven males, ranging in age from 25 to 56 years; average age, 38 years. The tumor had been present before operation

from four months to 30 years; average time, approximately six years. There were only two correct preoperative diagnoses. There were no operative deaths among our 18 collected cases. Pneumonia, hemorrhage, cerebral anemia and infection have been mentioned in the order of their importance as the causes of death. There were five deaths, however, from malignancy, occurring respectively nine months, eight months, four months, four years and four years after operation.

Total cases considered pathologically malignant, eight, or 44.4 per cent. In the Bevan-McCarthy review, there were 24 malignancies and recurrences, or 17.8 per cent; and in the Rankin-Wellbrock report, there were six malignancies out of 12 cases, or 50 per cent. One patient had bilateral carotid body tumors, with one growth malignant and the other benign. Thus, out of 13 specimens, six were malignant and seven benign, or 45 per cent malignant. Two of the cases returned to the Mayo Clinic later, with possible metastasis to the brain; one patient had symptoms of brain tumor, and the other of epilepsy, but these conditions were not verified by necropsy. Doctor Mathew's second case, where the tumor could not be completely removed, now has a recurrence the size of a walnut, but the patient is quite well otherwise, seven years after operation.

The total number of cases with common or all carotids ligated is seven, with no deaths. Bevan and McCarthy report 62 cases in this group, with 21 deaths—a mortality rate of 33.8 per cent; while Rankin and Wellbrock report three cases, all succumbing in the first 48 hours—a death rate of 100 per cent.

In our group of seven cases, four showed no evidence of brain damage following ligation of the common carotid artery; one had a temporary aphasia and hemiplegia; one had a partial right hemiplegia, right facial paralysis, and also paralysis of the vocal cord; and one had complete hemiplegia.

Total cases with postoperative disabilities—15, or 83.3 per cent. The morbidity ranged from slight, temporary paralysis to complete hemiplegia.

Symptoms and Diagnosis.—There are no symptoms or signs upon which the diagnosis of carotid body tumor can be made with certainty. Surgical dissection, best with aid of microscopic examination of the tissue, is necessary to settle the question definitely. Preoperative diagnosis appears to be difficult, for it has been made correctly in relatively few instances. It is believed, though, that this failure to make a tentative diagnosis is due to the fact that, tumors of the carotid body being rare and mimicking closely other more common growths, they are not even thought of. The clinical picture in the majority of cases reviewed seems to be rather uniform and characteristic. Usually there is a history of a single, smooth, deep seated, slow growing tumor in the upper cervical triangle, at the bifurcation of the common carotid artery; it may have been present for many years; it is usually painless—in fact, it gives rise to no symptoms at all, except the increasing deformity which accompanies its growth; it is not attached to overlying skin or muscles; it is ovoidal or rounded in shape; it is firm and elastic in charac-

ter—seldom soft or stony hard; it is movable laterally, but not vertically; in size, it may be as small as a hazelnut, or as large as a goose egg; it pulsates, but the pulsation is transmitted and not expansile, as in an aneurysm; rarely bruit and thrill may be present; compression of the common carotid artery below abolishes the pulsation, bruit and thrill, and often diminishes the size of the tumor. While the growth is practically always unilateral, Lund, Rankin and Wellbrock, de Tarnowski and Chase have reported examples of bilateral or probable bilateral tumors of the carotid body.

If other symptoms are present, they are due to pressure on the vagus, cervical sympathetic and recurrent laryngeal nerves, or upon neighboring structures, such as the tonsil, pharynx, esophagus, *etc.* Fainting spells, Stokes-Adams syndrome, hoarseness, cough, dilatation or constriction of the pupil, tinnitus aurium, headache, dysphagia, dyspnea, bulging of the pharyngeal wall, *etc.*, are symptoms that have been mentioned in the study of this subject.

Any growth, slow in its development, at or near the bifurcation of the common carotid artery, movable laterally, but not vertically, with transmitted, but nonexpansile pulsation, should be considered as a possible carotid body tumor. Carotid aneurysm, metastatic carcinoma, lymphoma, lymphosarcoma, tuberculous nodes, aberrant goiter, branchial cyst, branchiogenetic carcinoma, neurofibroma, ganglioneuroma, *etc.*, occurring in this region, may so closely simulate carotid body tumor as to make differential diagnosis difficult or impossible. Even at operation, certain growths which have been diagnosed as carotid body tumor have upon pathologic study proved to be something else. Microscopic examination alone can determine the true character of a suspected tumor.

Greene and Greene have suggested the use of the aspiration biopsy plan of Martin, or the punch biopsy method of Hoffman, in obtaining material for microscopic study in making a differential diagnosis in neck neoplasms. Other tumors of the neck, and also tumors of the breast, lung, bone, *etc.*, have been diagnosed by this plan. Certain growths, however, such as parotid or mixed salivary tumors, do not, we understand, lend themselves satisfactorily to this kind of study. It remains to be ascertained whether carotid body tumors can be recognized by this method. If, in the future, the pathologist can place a definite label on these growths before operation, and give an opinion as to malignancy or potential malignancy, then it follows that the surgeon will be able to lessen the high operative mortality and morbidity. Doctor MacNeal's comment, however, is: "Vascularity of these carotid tumors and the proximity to the carotid artery make one pause before trying aspiration or punch biopsy." Proper preliminary treatment might avert the danger of death from cerebral anemia and softening and avoid the serious major paralyses which so often follow ligation of the common or internal carotid arteries. Furthermore, there would be the opportunity of placing all the facts before an intelligent patient, so that due consideration could be given to the hazards

of surgical operation. The patient then could share with the surgeon some of the responsibilities.

Anatomy, Embryology and Pathology.—The recent literature contains 25 carotid tumors not included in the compilations of Bevan and McCarthy, 1929, and Rankin and Wellbrock, 1931. They have been reported from such widely separated localities as Canada, England, France, Italy, Scandinavia, South America, Africa, Russia, and Japan. Most of the authors have made case reports but a few have made elaborate studies and defined and emphasized certain points for consideration. We are referring in particular to the chromaffin cells and their relation to epinephrin, to the cells of the carotid

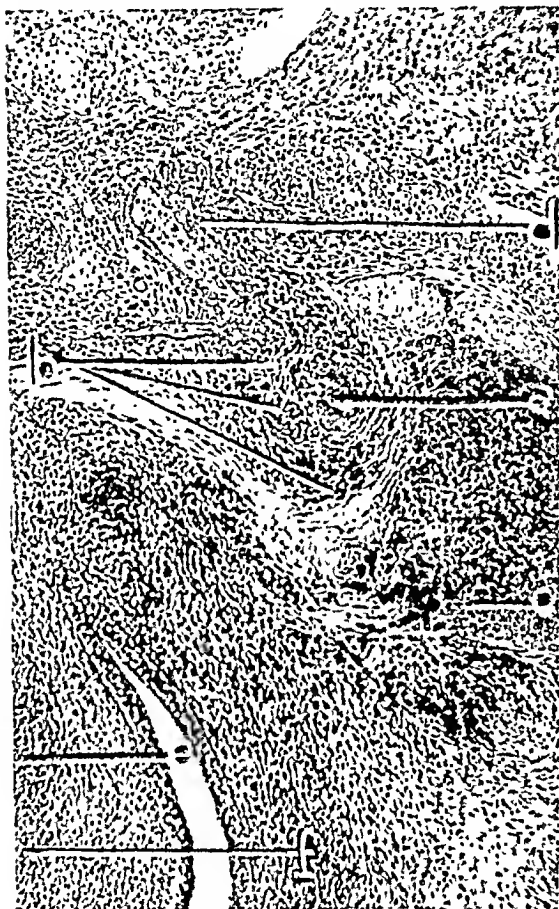


FIG. 3A.—Embryo "D," 45 days.



FIG. 3B.—Embryo, 44 days (Kcibel and Mall). (a) Carotid artery; (b) carotid anlagen; (c) superior cervical ganglion; (d) ganglion of vagus; (e) pharynx; (f) muscle.

parenchyma and the distribution of the sympathetic nerve elements. Each investigator has realized that a definite understanding of these important features is needed to enable the internist, the surgeon, and the pathologist to appreciate and deal with these puzzling tumors.

We may, indeed, come to abandon the designation "tumor" for that of compensatory hyperplasia, suggested by Chase, as the embryology, anatomy, physiology and pathology are more precisely understood.

Embryologically, the derivation of the cells forming the "glomus caroticum" was considered: first, a budding from the epithelium of the pharynx

(Stiedé); second, from the endothelium or from the adventitia of the carotid artery (Paultauf, Waldeyer, Funke); third, from blood vessels (Marchand); and, fourth, from the embryonic ganglion cells of the sympathetic plexus (Kohn).

The present conception of their origin may be summed up as follows: They arise from the neural tube as sympathogonia, that is, primitive cells of the sympathetic system, and, after arriving at the carotid bifurcation, differentiate into sympathoblasts or into chromaffinoblasts and, still later, into sharply demarcated chromaffin and sympathetic ganglion cell masses, the paraganglia (Zuckerkindl). They may be found in embryos of 19 Mm. or six weeks (Fig. 3), and are fully developed at ten weeks. Instead of maturing as indicated, their development may be arrested at any stage. Funke dissected eight fetuses and found a carotid body in one only and that on one side. After birth they may remain primitive or regress. Da Costa states the gland is frequently absent and Funke agrees to this both for embryos and after puberty. This may account in part for the rare occurrence of carotid body tumors. Developmental steps in other paraganglia duplicate those of the carotid bodies, all of which belong to the same chromaffin system. The best known are the paraganglia of the abdominal aorta (Zuckerkindl).

Anatomically, the carotid bodies are situated at or near the bifurcation of the common carotid artery and are the largest of the paraganglia included in the chromaffin system. They vary in size from a hemp seed to a grain of rice, 2 to 5 Mm., and are yellowish-pink. They may be formed of several nodules connected to the carotid vessels. They are also intimately connected with the superior cervical ganglion, the vagus, the glossopharyngeal and superior laryngeal nerves. They possess a thin capsule and fibers extend inward forming septa, separating groups of parenchymal cells, the "cell-balls." Dissection and microscopic studies have disclosed varying numbers of chromaffin and sympathetic ganglion cells. The septa carry numerous blood vessels and nerves which branch and ramify abundantly. The cell nests are enclosed in thin-walled capillaries (Figs. 4, 5 and 6). Nerves enter the cell nests and break up into small varicose tendrils, with button-like ends (Fig. 7). According to Dietrich, the relation of the cells to the nerves is more intimate than to the blood vessels. Ganglion cells both in clumps or scattered are found in the capsule and occasionally in the interstitial tissue. Chase, and Bertrand and Sauvage in two recently published papers consider the nerve elements of more histologic value than the chromaffin cells. By special staining (Bielschowsky), it is possible to demonstrate specialized nerve fibrils in the cell nests as in paraganglia (Fig. 7). Throughout the literature it is notable that some investigators have found chromaffin cells in normal carotid bodies and in tumors and others have not. The latter statement is emphasized by Callison, Bevan and McCarthy, and recently by Chase and by Cragg. The significance of the chromaffin cells has been variously estimated. They are distinguished by granules in their cytoplasm that stain yellowish-brown with

chrome salts (Stilling), are positive for Vulpian's iron test and stain with osmic acid. The granules are considered as epinephrin granules (Kohn), as

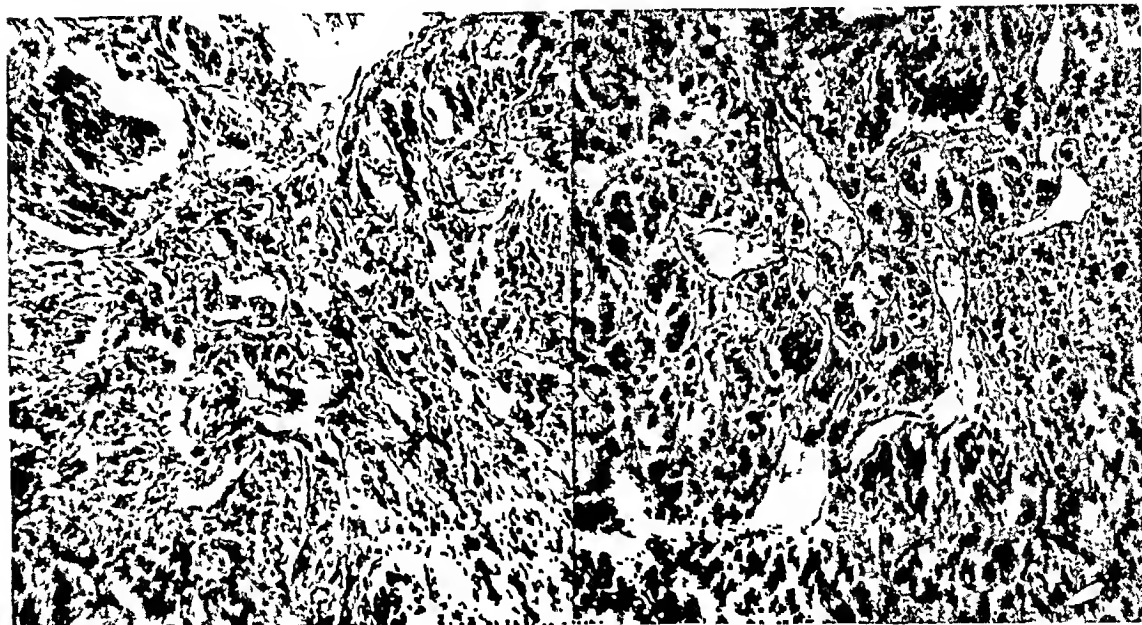


FIG. 4.—(Path. 41429, Doctor Peterson's first case.) High power photomicrograph showing cell nests and ramifying blood vessels. Paraganglioma (malignant?).

FIG. 5.—(Path. 63892, Doctor Peterson's third case.) High power photomicrograph showing cell nests and ramifying blood vessels. Paraganglioma.

precursors of epinephrin (Chase), as not related to epinephrin (De Castro). Miller, by special staining, identified epinephrin in the blood plasma.

In addition to histochemical reactions, extracts of the carotid bodies and

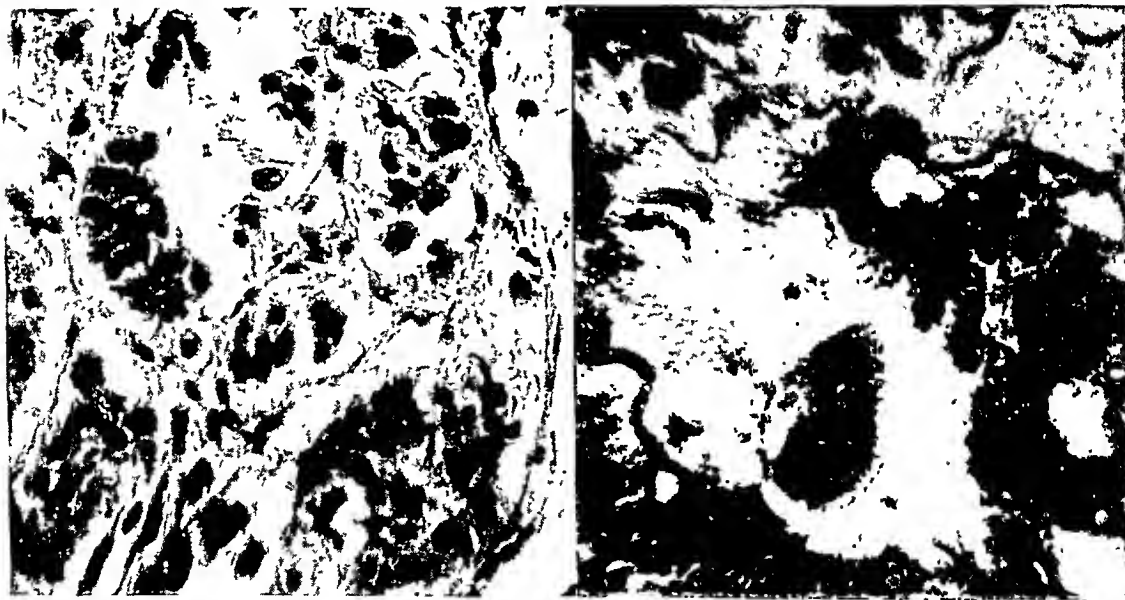


FIG. 6.—(Section of Fig. 5, at higher magnification.) Large polyhedral cells with granular cytoplasm forming the cell nests.

FIG. 7.—(Section of Fig. 5, at higher magnification.) A nerve fibril with button-like end is seen passing to the epithelium (Bielschowsky stain).

tumors have been injected into animals. Mulon produced a rise and Gomez a fall in blood pressure. The failure to find chromaffin granules or positive reactions for epinephrin indicates either that the granules are exhausted or

have no relation to epinephrin. This lack of relation is strongly supported by many, among them Nordmann and very recently Cragg.

We may sum up the contradictory evidence on carotid body tumors by several facts. Its inconstant presence, its atrophy at puberty, the questionable results of experimental work and the lack of definite symptomatology all indicate that the function of the carotid body is probably not important. That it has an internal secretion is now considered very doubtful.

In studying the tumors of the carotid bodies, it is necessary to consider tumors of other paraganglia of the chromaffin system. The literature con-

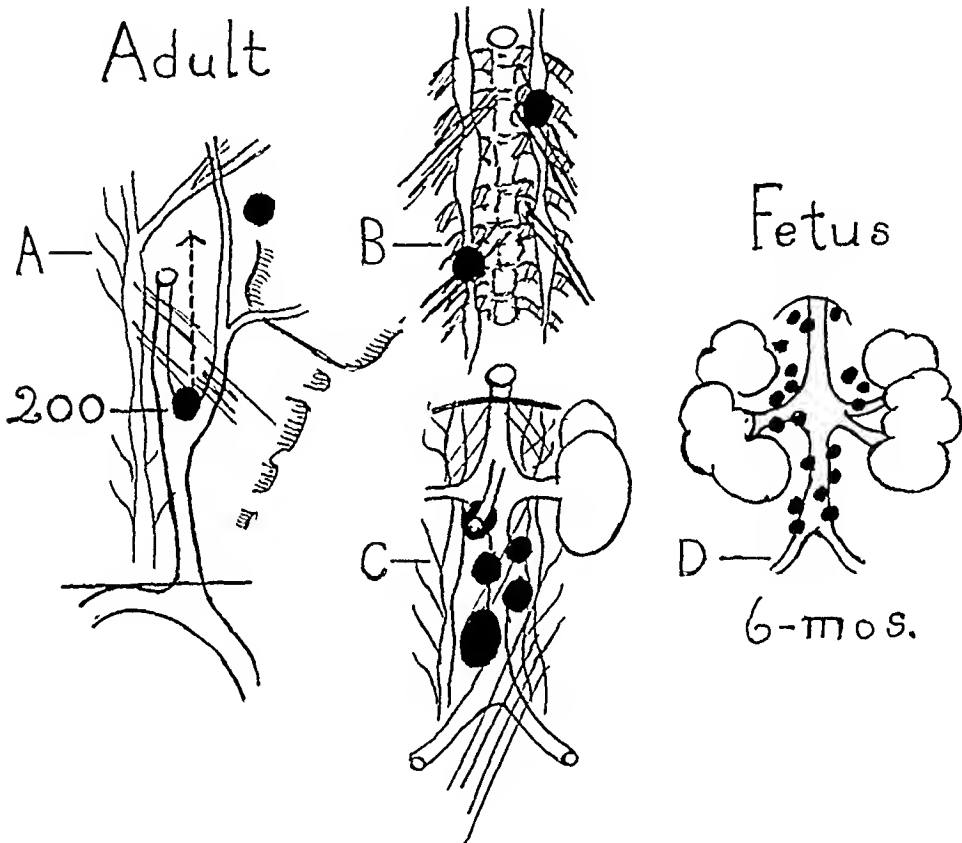


FIG. 8.—Schematic drawing. The black masses indicate paragangliomata. (A) 200 + located at the bifurcation of the carotid artery. (B) Thoracic paraganglioma between fourth and fifth, and ninth and tenth ribs. (C) Aortic paraganglioma (Zuckerkindl). (D) Common distribution of chromaffin bodies in the fetus.

tains eight examples, Stangl, Hausmann and Getzowa, Miller, Handschin, Nordmann and Lebküchner, Lebküchner, and Cragg (Fig. 8). The first were isolated tumors but Cragg found coincident carotid and Zuckerkindl body tumors. Necropsies were performed, the histology studied, and chromaffin and epinephrin tests made. The findings, both positive and negative, duplicate those of carotid body tumors.

Grossly carotid tumors are similar and have been called "potato" tumors from their size and shape. Their color varies from pale gray to yellow to dark reddish-gray, the consistency varying largely with the blood supply.

Microscopically, there is more variation, and many names have been ap-

plied according to the cell differentiation, histologic details and interpretation of the findings. More than 90 per cent have a common histologic picture. They have been called carotid tumor and perithelioma for the most part. Some have been designated endothelioma and paraganglioma, a few angioma, angiosarcoma and neuroblastoma. Miller suggested sympathetic naevus or carcinoid. Paraganglioma is the present accepted term since paraganglionic elements have been repeatedly demonstrated (Miller, Chase, Cragg): namely, chromaffin, epinephrin, and sympathetic nerve terminals.

In Doctor Peterson's second case, the chromaffin reaction was faintly positive in peripheral portions and the nerve elements were characteristic. Tests for epinephrin were not made.

As regards the malignancy of the tumors of the paraganglia, the clinical course and histology do not always agree, as in Doctor Peterson's first case. Proof of malignancy has been doubted in some cases. The possibility that the carotid tumors are examples of compensatory hyperplasia has been suggested. The patients with carotid tumors are commonly without symptoms.

Comparisons of blood pressure before and after removal of the carotid tumor have not been recorded in sufficient numbers to aid our understanding. Necropsies are few and so dissections for possible anomalies, enlargements or atrophies of other paraganglia of the chromaffin system have not been adequately investigated.

The bilateral occurrence, the occasional tumors of the paraganglia duplicating the carotid body tumors, the rare familial incidence and the single example of coincident carotid and aortic paraganglioma suggest systemic or hereditary factors for their production.

These tumors are associated with the nerve elements of the sympathetic system and possibly occupy a position similar to the von Recklinghausen group of tumors.

Treatment.—There is among surgeons unanimity of opinion as to the ideal treatment of carotid body tumors. Early and complete removal, if it can be accomplished without the sacrifice of important blood vessels, is the method of choice. On the other hand, there is considerable difference of view as to the proper procedure if the tumor cannot be removed without ligation of the carotids. Ever since Keen, in 1906, advocated conservatism, after reciting the unfortunate outcome following carotid ligation in his only case, numerous writers have warned against radical surgery in the treatment of these cases. Bevan, in 1929, made an eloquent and convincing plea that "in the future, neoplasms of the carotid body should not be removed when it is necessary to ligate the carotid arteries in order to complete the operation." His case, subjected to an exploratory operation only, and later given roentgen ray treatment, recovered completely, and has remained well to date. This case is unique and such a recovery will not frequently be duplicated, for the records indicate that the great majority of cases treated by roentgen ray and radium have resulted in failure. Sullivan believes that treatment can only be surgical. Royster says that prompt recognition and early removal,

even at the expense of resection of important blood vessels, appears to be the only rational treatment.

How can the mortality of over 30 per cent and the incapacitating disabilities, so often present in surviving patients, be lowered? We are convinced that both mortality and morbidity can be reduced, and we offer the following suggestions: (1) That a clinical diagnosis can and should be made; (2) that every suspected case, unless urgency of symptoms forces quick action, should have systematic compression of the common carotid artery against the large anterior tubercle of the transverse process of the sixth cervical vertebra, several times a day for a few weeks, in order to develop collateral circulation in the brain on the affected side; (3) that the operation should be an exploratory one, and if the growth cannot be removed without ligation of the carotids, that a biopsy by the Hoffman punch method be made, to settle the question of possible malignancy, after which a temporary ligature or Halsted metal band be placed around the common carotid artery to determine the success or failure of the preliminary treatment aimed at establishing adequate collateral circulation and avoiding cerebral anemia and softening. Nothing further is done at this stage—the wound is closed, and developments are awaited. The ligature or band is to be removed at the first signs of hemiplegia. If the biopsy specimen shows evidence of malignancy, a decision must then be made as to whether radiation treatment or radical surgery will be employed. If, however, no symptoms of brain damage appear, a secondary operation can be performed and the complete removal of the neoplasm accomplished with but little risk.

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DISCUSSION.—DR. FRANK S. MATTHEWS (New York) presented a patient operated upon nine years ago at the age of 58. There had been noted a tumor of the left side of the neck under the angle of the jaw, the size of a large hen's egg. Examination showed the left tonsil pressed far inward. There was some difficulty in breathing, especially during sleep. The tumor could not be displaced downward in the neck. Under rectal anesthesia the tumor was removed. A flap was raised over it including the platysma muscle. The tumor was definitely encapsulated. The hypoglossal nerve was stretched tightly across its surface. It lay between the external and internal carotid arteries, hence undoubtedly within the carotid sheath. It extended up under the jaw to the base of the skull. On reaching its capsule it was largely enucleated with the finger. The internal jugular vein was scarcely seen and was displaced far outward. There was no asymmetry of the pupils. Post-operatively the tongue was partially paralyzed, as was also the left vocal cord. The patient had great difficulty for a number of days in clearing the throat of saliva. The microscopic report was neurofibroma from the carotid sheath. Clinically, the tumor had most of the signs of a carotid body tumor though not of the usual pathologic variety which is often described as perithelioma. There was no thrill or bruit as is present in some cases.

The speaker had seen three other cases which he had diagnosed as tumors of the carotid body. The first case, many years ago, was explored but proved inoperable. It was malignant and proved fatal in about two and one-half years. The second case was operated on after he had had an operation elsewhere ten years before. The tumor recurred and at the reoperation in 1928 it was removed, although undoubtedly not quite completely, as it has recurred and is slowly growing. Removal could have been complete if one were willing to sacrifice the carotids which would probably have resulted fatally. Had the external carotid been sacrificed, it might have been possible to do a complete operation. The tumor is no doubt benign. At the original operation part of the seventh, ninth, tenth, and twelfth nerves were injured. The patient has a hemi-atrophy of the tongue, paralysis of the vocal cord and some anesthesia of the pharynx. If another operation were done the speaker would not hesitate to divide the external carotid but would not chance ligating the internal. His last case was a woman of advanced years who had been observed at intervals for a dozen years. The tumor presses the tonsil and pharyngeal wall inward, and is increasing little if at all. The mass feels cystic as palpated through the pharynx, much suggesting a peritonsillar abscess. An aspirating needle was once inserted and drew blood. There is a distinctly expansile character to the tumor.

DR. HOWARD LILIENTHAL (New York) said that, although not having studied the subject embryologically or from the standpoint of minute pathology, he had done so clinically, beginning with a case in 1906, and another three years later, and that he had been especially interested in an article by Callison and McEnty in 1913. Doctor Lilienthal's first case had had an enormous tumor of the neck that proved to be inoperable. However, he removed as much as possible and Doctor Elsberg tried later to remove more. The patient died of recurrent hemorrhage a week or so after operation. Had Doctor Lilienthal known the nature of the tumor he would not have attempted to extirpate it. In his second case, he was able to make a diagnosis, though it was not absolute until confirmed by operation. The patient, a woman—the tumor occurring much more frequently in women than in men—had had the tumor for 30 years before it began to enlarge. At operation, the carotid was exposed and the tumor found to be so intimately ad-

herent to the carotid that it was necessary to sacrifice it. It was resected, together with the tumor and the internal jugular vein, the vessels being used as a handle to aid the dissection of the tumor. A number of years afterward there was a recurrence and the patient died.

At that time, it was generally thought by surgeons that tumors of the carotid body very rarely metastasized but that they almost always recurred locally, and, in Doctor Lilienthal's opinion, the reason for recurrence in his case was because the vessels were not extirpated, which should be done in a case of this kind because it is malignant. He said that in any future case with a reasonably certain diagnosis he would expose the common carotid quite low down, put a thin rubber band, not too firmly, around it so it would not occlude the vessel, and leave it there. The rubber band, being elastic, would gradually compress the artery so that in a week or ten days it should be possible to go ahead safely with the second stage of the operation, with a minimum danger of a cerebral lesion. If, meanwhile, signs of cerebral disturbance should develop, the rubber band could be removed.

DR. JOHN DOUGLAS (New York) called attention to the fact that many cases of carotid tumor go on for a number of years with the tumor small in size, then apparently it becomes malignant and increases rather rapidly. Therefore, it is an exceedingly difficult problem to determine what should be done in these cases where there is so much danger from operation; that is, both a high mortality and morbidity. At the time Doctor Douglas reported the only case in his experience (1909), Keen had collected some 27 cases which, in addition to five that Doctor Douglas found, made 32 cases, in which there was 25 per cent mortality with 20 per cent of those not succumbing to operation having a recurrence and dying from that recurrence. In two-thirds of the cases, all three of the carotids were tied, which was one cause of the mortality, but in the group there had also been injury to the pneumogastric nerve, the sympathetic nerves, the recurrent laryngeal, superior laryngeal, hypoglossal or facial. With such a result, Keen advocated not operating on these cases. Several years later, Bevan, collecting a series of cases, reiterated this conclusion, stating that the mortality and morbidity made operation prohibitive. However, if the patient is seen at a time when the tumor is still removable—in Doctor Douglas's case it was only 1.5 by 2.5 by 3.5 cm.—and could be peeled out carefully from the external and internal carotid at the bifurcation, operation is indicated. On the other hand, if the tumor is large, the common carotid artery must be ligated; this must be done in large tumors infiltrating the carotid and surrounding tissue, and a useful preparatory procedure is to obtain graduated pressure by means of a Halsted clamp, or by putting a piece of fascia around the vessel, or by pressure against the carotid tubercle. By such means, one may determine when it is safe to take out the tumor. But Doctor Douglas would not consider it safe to put a rubber band around a blood vessel, as suggested by Doctor Lilienthal.

DR. CHARLES E. FARR (New York) recalled that he recently reported at a meeting of the New York Surgical Society two cases of carotid body tumor from the records of the New York Hospital. One was a personal case in a young woman who had had the tumor a number of years and who made an excellent operative recovery. The tumor was of a mildly malignant nature and did not recur during a fairly long period of observation.

The second case was operated upon by Dr. Richard Meagher, on the service of Doctor Heuer. This was a middle-aged woman with a very ex-

tensive malignant growth which could not be entirely enucleated. She recovered and under radiation has remained well so far as her neck is concerned. Doctor Meagher reports, however, that she has had an entirely independent neoplasm, a carcinoma of the sigmoid, which has been operated upon with success and she is now apparently well.

Doctor Farr then reported a third case which was considered to be a carotid body tumor but which on pathologic study is considered very doubtful. This was in a young Italian man, 32 years of age, who entered the New York Hospital July 18, 1935, and was discharged July 30, 1935. He was a printer by occupation. For three years he had had a slowly increasing growth at the angle of the left jaw, without symptoms. Since January, 1935, the growth had become much more rapid. He had had frequent colds and carious teeth but no sore throats.

Physical examination revealed nothing abnormal except a mass about 5 cm. in diameter, in the left neck below the angle of the jaw. This pulsated markedly and was definitely in the carotid notch. It could be moved laterally but not upward or downward. It was not expansile. Pulsation could be seen. The mass was free from the skin, was beneath the muscles and seemed to diminish slightly on pressure. The pupils were equal and reacted normally to light and in accommodation. The left optic nerve head appeared slightly hazy.

He was operated upon, after the subsidence of a mild febrile reaction, through a T shaped incision. A large tumor was found filling the carotid notch and extending into the depths of the neck. The dissection from the carotid vessels was quite difficult and somewhat bloody. Deep dissection was accomplished by blunt enucleation and was only moderately bloody. There was no pedicle.

Two days postoperative, a Horner's syndrome was noted and this has persisted since. The wound healed without complications. The patient's general health is excellent at present. Horner's syndrome is still present. The pathologic report by Doctor Foote is as follows: "The specimen consists of a pyriform tumor measuring 6 by 5.5 by 3.7 cm. and weighing 56 Gm. It is composed of several lobules of firm, yellowish tissue separated by more vascular areas. On section it seems to be made up of areas of whitish tissue which is extremely vascular and arranged in convoluted fashion. In the center there is a reddish area 2.5 by 4 cm. which may be necrotic or very vascular. Accompanying the specimen are two lymph nodes and surrounding tissue. One node measures about 1.5 cm. in diameter and is firm and yellowish. The other packet of lymph nodes measures 3.5 by 1.5 by 1 cm. and is quite similar in appearance to the foregoing. It is apparently composed of three or four lymph nodes, more or less grown together. Contrary to expectations, the sections from this tumor show nothing resembling carotid body. It is composed of rather cavernous, vascular channels embedded in a very dense fibrous matrix in which collagen predominates. The cellular elements of the fibrous tissue tend to be grouped in a somewhat palisaded form, as in the case of a neurinoma, but Masson stains show no nervous elements whatsoever and the tumor appears to be a hemangiofibroma. The accompanying lymph nodes are covered on one side with a capsule and present a fairly normal architecture. There is a slight degree of fibrosis and some increase in the number of endothelial cells, indicating a mild, chronic, inflammatory process. *Diagnosis.*—Angiofibroma. Mild, chronic lymphadenitis." Doctor Foote states that he could not absolutely exclude the possibility that this is a form of tumor of the carotid body.

A slide was submitted to Doctor Ewing, whose report is as follows: "In the case of R. F. I am inclined to think the tumor of the neck is a peculiar form of fibrosing neurinoma, arising in a nerve trunk. The palisade arrangement of the cells is extremely suggestive of this tumor type. In spite of the absence of nerve elements by Masson's stains, I am disposed to hold to the diagnosis just the same. It has nothing to do with the carotid body."

DOCTOR PETERSON thought that surgeons were inclined to consider carotid gland tumors more malignant than is the pathologist. The histologic picture is suggestive of a benign condition, although it is known that a definite percentage of these cases are clinically and actively malignant in their behavior. Only two cases in the literature have developed distant metastases and it was questionable in these cases. Tumors of the carotid body recur locally, but do not tend to metastasize at a distance.

DIGESTIVE PHENOMENA IN THE PSYCHOPATHIC PATIENT*

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PHILADELPHIA PA.

IN THEIR association with the surgery performed upon the patients from the Psychopathic Wards of the Philadelphia General Hospital, the authors were impressed several times with the great discrepancy found between the clinical findings before operation and the conditions found at the operation or on the autopsy table. The thought consequently occurred as to whether a patient with a mental disease resulting in aberrations could not conceivably have associated nerve cell lesions that resulted in fallacious or at least misleading visceral symptomatic phenomena causing erroneous diagnoses. An attempt is made by reference to the literature and by an analysis of 15 cases to direct attention to this question.

In a recent contribution, Frazier, Watts and Uhle have given an excellent review of the literature on the investigations upon the influence exerted by the cerebral cortex upon gastro-intestinal activity. They mention the works of Watts and Fulton, who by faradic stimulation of the premotor area in monkeys produced marked increase in the peristaltic activity of the cecum and lower part of the small intestine, with often "peristaltic rushes" in the colon. Frequently, ring-like bands of contraction of the small intestine developed during the stimulus. The persistence of such bands aided by the active peristalsis results in some instances in an intussusception, often multiple, which did not produce obstruction under the conditions of the experiment. These same writers, however, in the course of performing autopsies upon monkeys subjected to operations upon various parts of the brain and spinal cord, found intussusception with obstruction to be the cause of death in three otherwise healthy monkeys.

Morbid hunger in cases of brain injury is mentioned by them as being described by Paget, Spiller, *et al.*, and Bruhn is quoted as saying that this is not due to increased metabolism. Fulton is quoted as thinking it is secondary to the hurried peristalsis and Watts adds that this rapid rush and consequent imperfect absorption may account for the frequent emaciation existing.

The frequency with which psychopathic patients have morbid hunger and other abdominal phenomena that result in foreign body ingestion should be borne in mind. Every physician or surgeon is familiar with the fact that a correct, complete, and intelligent history is one of the most if not the most important factor in many of our diagnoses. The proper description of the

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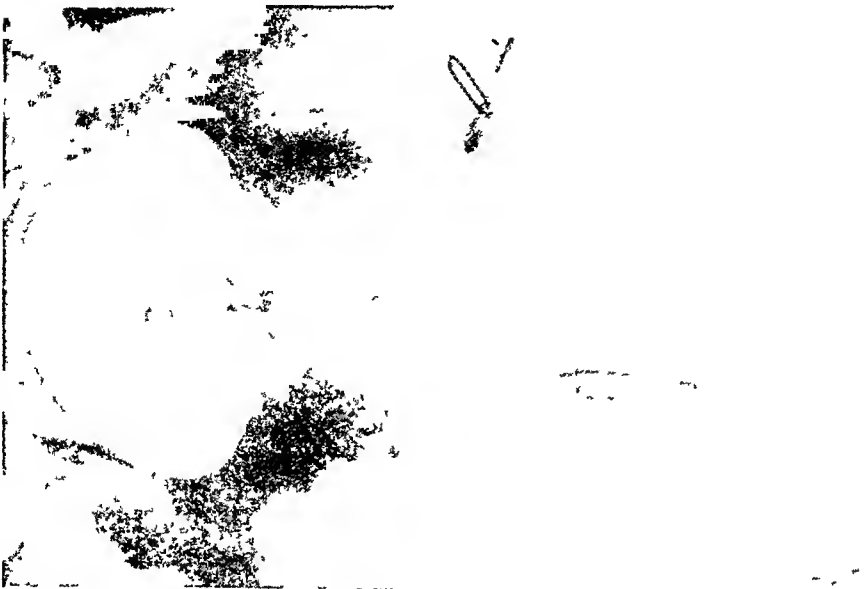


Fig. 1.—(Case I.) Closed safety pins in gastro-intestinal tract.



Fig. 2.—(Case II.) Paper, rags, hair, stones, Japanese beetles. Intestinal obstruction.



Fig. 3.—(Case III.) Dessert spoon in stomach. Dementia praecox.

pain or discomfort is very essential before significance can be attached to it. The psychopathic or insane patient cannot be relied upon for this help; hence the danger of erroneous diagnoses.

The same writers state that epigastric aura and other visceral sensations associated with convulsive seizures or occurring independently usually are not so called referred sensations but are the result of vigorous or abnormal gastro-intestinal movements. They also give evidence that urinary bladder representation exists in the cortex and hypothalamic region, stating that the abnormalities of bladder function, tone, and sensation in patients with brain tumors are probably the result of a disturbance of bladder representation in certain parts of the brain or tracts descending from them. Cushing some years ago called attention to the relation between the existence of peptic ulcer and certain brain lesions.

The mimicry of visceral disease, the result of the influence exerted by the cerebral cortex upon gastro-intestinal activity, may be illustrated by the following instances:

CASE REPORTS

CASE I.—Several years ago the senior writer saw a man in the Psychopathic Ward of the Philadelphia General Hospital who was thought to have a perforated peptic ulcer. The patient was a male, aged 38, of the slender, ulcer type so well described by Draper. The history was that about three hours previously he had been seized with a severe prostrating pain in the upper right quadrant of the abdomen, followed by nausea and vomiting. Physical examination revealed a T.P.R. of 98° — 124 — 24 . The patient lay on his back in a flexed or frozen position with knees slightly flexed. The abdominal wall had a boardlike rigidity, tender and resentful. Peristalsis was absent and the leukocyte count was 14,000. A diagnosis was made of perforation of a duodenal ulcer. At operation the peritoneal cavity was found normal with no evidence of peritonitis or perforation. The patient died 48 hours later and at autopsy no cause of death was discovered.

CASE II.—The second in this same hospital, also a psychopathic case, was a man aged 52, admitted with the chief complaint of acute abdominal pain of five hours' duration. This pain began suddenly, was prostrating in character, and was located just to the left of the umbilicus. He had vomited. Examination showed a stout adult who lay absolutely immobile on his back. The abdomen was distended and revealed a right rectus scar of an operation four years previously for a "stomach ulcer" for which a "short circuit was done." There was boardlike abdominal rigidity and no peristalsis could be heard. The T.P.R. was 99° — 120 — 22 . Leukocyte count, 11,000. Tests for syphilis were negative. A diagnosis of perforation of a marginal jejunal ulcer was made. At operation the abdominal cavity was found to be normal except for the innocent adhesions incident to the well healed gastrojejunostomy. There was no evidence of a healed ulcer. This patient died within 72 hours and the autopsy revealed no cause for death.

CASE III.—A third psychopathic case was a young Negress, 17 years of age, admitted to the hospital with abdominal distention equal to that of a pregnancy at term. The chief complaint was this distention and constipation although bowel movements could be obtained with laxatives. A thorough study of the case showed nothing of significance upon which to base a diagnosis. The spinal Wassermann was negative. The provisional diagnoses were tuberculous peritonitis or partial intestinal obstruction. Exploratory operation was undertaken. When the spinal anesthesia was given, the abdominal distention rapidly subsided, until in a short time it completely disappeared.

The exploration was carried out and a normal abdominal cavity disclosed. This patient recovered and at a later date was found to be in the habit of swallowing foreign bodies, chiefly small pieces of wood, several pieces of which were recovered in her bowel movements.

The above experiences led to the thought that possibly mental diseases might be responsible for gastro-intestinal phenomena similar to gastric crises or syndromes mimicking abdominal pathologic conditions, such as ulcer, intestinal obstruction, *etc.* If this were true, then, possibly there might here be a reason for those cases with real clear cut diagnoses of peptic ulcer which have shown no ulcer at operation. We have all seen and operated upon the "queer" patient with bizarre digestive symptoms suggestive of ulcer and yet not giving a typical picture, and operation has found no cause for, nor given relief to, the symptoms. Two brief histories will illustrate the points:

CASE IV.—A young man in his thirties was known to have paresis and the abdominal picture associated therewith. A gastro-intestinal roentgenologic examination reported a perforating prepyloric gastric ulcer. At operation a complete and exhaustive search revealed nothing. The patient's abdomen lent itself to an easy exploration in that the stomach and duodenum were very mobile. To be more certain, a gastrotomy was done and the lesser curvature evaginated through the opening. No ulcer was discovered.

CASE V.—Another patient presented himself with the history that he had had a gastrojejunostomy for a duodenal ulcer five years ago. He stated that the doctor told him that his case did not "fit" the pain picture, although an ulcer was found at operation. He was free from symptoms for one year and then different symptoms began in the nature of more or less constant pain in the upper left quadrant radiating to the back, but with no relation to food, yet was made worse by excitement or worry. Studies disclosed a normal functioning stoma. A definite diagnosis could not be made, after two or three complete and thorough hospitalizations. He was seen by a neurologist, who suggested a possible neurosis, and he was sent to a hospital for observation for several months. Later, the patient consented to an exploratory operation and two large perforated gastric ulcers were discovered.

The next group of patients, those who intentionally swallowed foreign bodies, are very interesting. There are many of these in the psychopathic wards, many more than are discovered. It is only when sickness justifies an examination that roentgenograms are taken of these patients and such foreign bodies discovered. It is reasonable to believe that many such cases giving no symptoms probably pass out bodies by the normal route. Why do they swallow pins, nails, spoons, hooks, glass, *etc.*? Is it because of abnormal hunger, or is it because of some peculiar and strange desire that a digestive disturbance causes? Many of the patients when asked why they swallowed such things will state because they had indigestion; others will deny having done so. Can these phenomena be abnormal visceral impulses with their source in a diseased brain?

Insane and psychopathic patients are prone to swallow foreign bodies because of no known reason, or from suicidal intent, or spite. Occasionally they are observed to do so, often they are not. When the latter is the case,

the attending physician is frequently misled in making a diagnosis, as the case is first apt to present itself to him as an acute abdomen. Often the patient is admitted to a surgical service with a diagnosis of intestinal obstruction, acute appendicitis or perforation of a hollow viscus. The objects swallowed may consist of any object that the patient takes a fancy to and which is capable of being ingested. Generally the objects are metallic or opaque to the roentgen ray, though two of our patients swallowed lead pencils and wooden tongue depressors.

Our experience with these patients has led us to the conclusions that a



FIG 4—(Case VIII) One hundred nails in the gastro intestinal tract

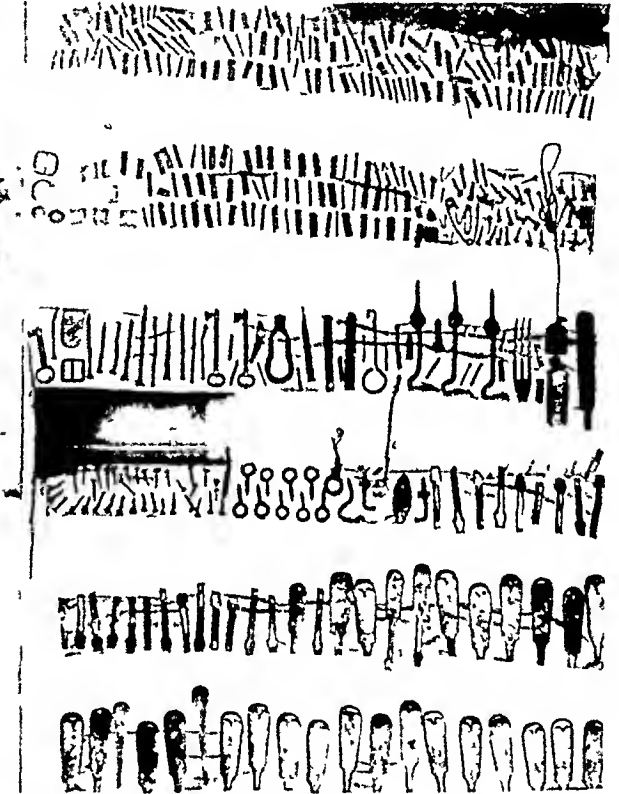


FIG 5—(Case IX.) Four hundred fifty six foreign bodies removed from the stomach Total weight, three and one half pounds

flat roentgenogram should be made of the abdomen in all feeble-minded or insane patients who complain of abdominal distress which persists for more than several hours. Whether it is known that the patient has swallowed a foreign body or not, the diagnosis and location of the object rests upon roentgenologic examination.

The concomitant train of events which follow such depraved cravings may prove serious or not depending upon the clinical course of such patients. Apparently the gastro-intestinal tract is able to overcome many insults, whether of an alcoholic, metallic or medicinal nature. Surgical intervention is not always, but, rather, only occasionally necessary. When performed it should be judicious. Occasionally an acute surgical abdomen re-

sults from such abnormal ingestion. Largely in our experience, however, foreign bodies in the intestinal tract are well tolerated and seldom prove to present an immediate surgical problem. Frequently the objects are eliminated during the course of observation and conservative study. Indiscriminate surgery is not justifiable. As in so many conditions, the patient, rather than the roentgenogram, should be treated. Perforations of hollow viscera occur, certainly. The occasional occurrence of such catastrophes, however, is no warrant for general operations performed without adequate preoperative study, treatment, and preparation. This is especially true where there are multiple foreign bodies scattered throughout the intestinal tract and where multiple enterotomies serve only to increase the operative mortality.

The patient most often will not disclose the fact of having swallowed

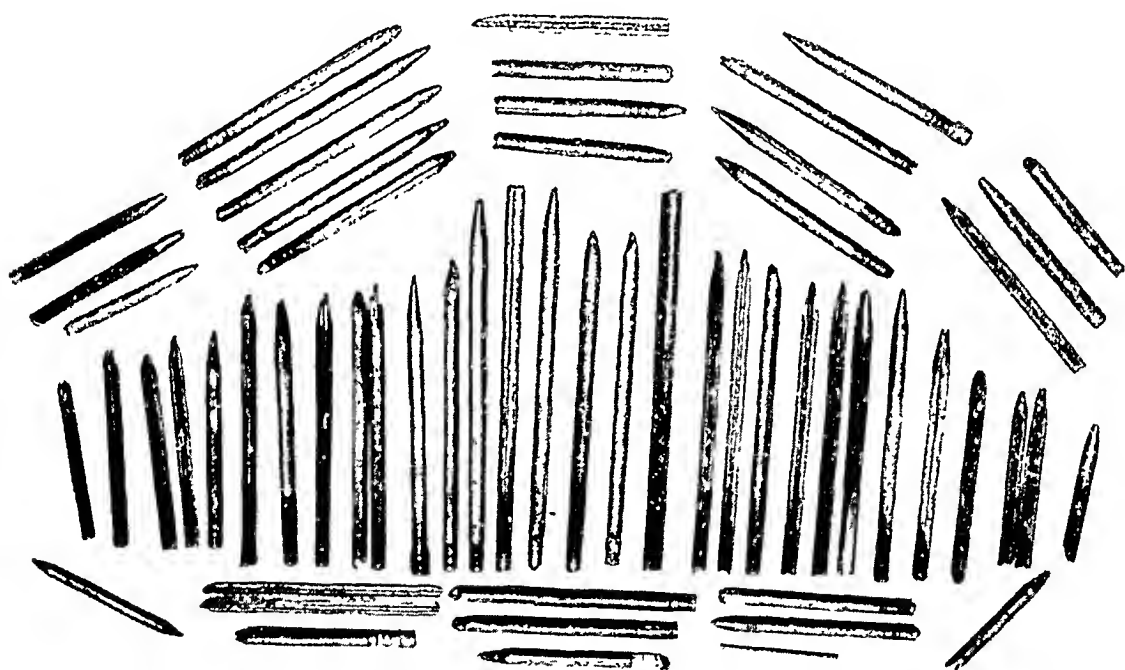


FIG. 6.—(Case X.) Fifty-nine pieces of lead pencil removed from the stomach and one from a perforated cecum.

anything unusual. Sometimes they will volunteer the information. They frequently give indigestion as a reason for the habit; other times they have no reason. The character of the objects swallowed depends to some extent upon what is most easily obtained and may vary considerably, ranging from a cigar lighter to printers type. Some patients are selective in their diet, restricting themselves chiefly to spoon handles, or to safety pins, nails, screws, pencils, screweyes, *etc.* It has further been observed that a particular individual frequently develops a habit in that he will swallow all or most of his safety pins closed, whereas the next one's habit makes him prefer most of his pins opened or even straightened out. One patient's cecum was filled with Japanese beetles; another's rectum and sigmoid was packed solid with coffee grounds. These individuals often persist in their unusual appetites

after an operation and have been known to swallow mouth thermometers, wooden tongue depressors or safety pins removed from their dressings. Again they are selective in that in our experience they will rarely swallow a whole spoon, but usually break off the handle and swallow it, discarding the bowl. They do not swallow fork handles—probably because forks are not furnished them. In the hundreds of ingested articles only one fork was discovered.

Table I presents in condensed form the salient points in the histories of ten cases that are illustrative of the association between psychopathic conditions and abnormal gastro-intestinal activities producing fallacious deductions and many times unwarranted diagnoses.

TABLE I

Case	Age	Diagnosis	Digestive Symptoms	Objects	Treatment	Result
6	39	Psycho-neurosis	Indefinite	Safety pins, closed (Fig. 1)	Scope	Recovery
7	55	Puerperal psychosis	Vomiting, pain, ileus	Paper, rags, hair, stones (Fig. 2)	Oper.	Death
8	23	Dementia praecox	Pain in abdomen	Spoon in stomach (Fig. 3)	Oper.	Recovery
9	35	Mental defective	Pain, nausea, vomiting	Pins in stomach	No oper.	Recovery
10	35	Mutism, pervert	Colicky pains and vomiting	Safety pins and nail (?)	No oper.	Recovery
11	19	Psycho-neurosis	Abdominal pain and vomiting	Tongue depressor, swabs, thermometer	Oper.	Recovery
12	61	Manic depression	Belching, suicidal attempts	Vial in stomach	No oper.	Recovery
13	45	Undiagnosed	Ulcer symptoms for four years	100 (?) tenpenny nails (Fig. 4)	No oper.	Recovery
14	40	Dementia praecox	Indigestion	456 foreign bodies (Fig. 5)	Oper.	Recovery
15	25	Undetermined	Abdominal pain (appendicitis)	Lead pencils (Fig. 6)	Oper.	Recovery

In the entire series there are ten other cases who swallowed foreign bodies, none of whom had complained of any abdominal symptoms previous to operation. Some of these were discovered incidentally in the excreta and in others a roentgenogram taken for other reasons revealed their existence.

We wish to take this opportunity to express our appreciation to the other members of the Staff of the Philadelphia General Hospital for their kindness in allowing us the privilege of reporting cases from their services.

CONCLUSIONS

(1) The inability of a psychopathic patient to clearly define his symptoms renders diagnosis more difficult.

(2) Mimicry of visceral symptomatology further increases the difficulty of a correct diagnosis.

(3) The human gastro-intestinal tract is shown capable of expeditiously caring for many most extraordinary, variable and numerous foreign bodies. Consequently too hasty surgery in the absence of symptoms is unjustifiable.

(4) It is still as dangerous as ever to attribute symptomatology to a suspected psychoneurosis.

LIVER STONES

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MOSCOW, U.S.S.R.

TRANSLATED BY ARTHUR J. WALSCHEID, M.D., OF NEW YORK, N. Y.

(Continued from page 336)

CLINICAL PICTURE, SYMPTOMS AND DIAGNOSIS.—The clinical picture of hepatolithiasis varies greatly. On the whole it resembles the clinical forms of cholelithiasis, ranging from the symptomless stone carriers to cases presenting the evidence of obstruction of the bile ducts, such as jaundice from stasis, liver insufficiency, cholangitis, liver abscess and sepsis.

It is very difficult to find characteristic liver stone symptoms and differentiate them from those seen in cases of gallstone, because in the great majority of instances gallbladder, bile duct and liver stones coexist. Long duration of the condition, its obstinate resistance to all form of treatment and the advanced age of the patient when stones are found at operation or autopsy appear to predicate liver stones. Liver stones in younger people (such as in Fedorow's case of a boy 13 years of age who had suffered for three years), are characterized by their long duration and marked infection (possibly secondary).

Sex plays no part in its relative frequency. In cholelithiasis, the ratio of men to women is 1 to 456. In hepatolithiasis, the ratio is equal, 1 to 1; in fact, more men seem to be affected than women. In Japan and China, these figures vary from 1 to 1, to 5 to 9, in cholelithiasis. In 613 autopsies, 306 were women.

Notwithstanding the long duration and obstinacy of the disease, selective operations are few. Repeated operations, however, are more frequent than in usual cases of cholelithiasis. We find a large percentage of autopsy material showing nearly 30 per cent in this condition without having had any previous operation.

Peritonitis or perforation are scarcely ever found at operation or autopsy and only in the more severe cases do we find cholangitis, liver abscess, marked liver insufficiency or sepsis. The percentage of complicated and aggravated cases is larger in this disease. We will later present the varieties of hepatolithiasis occurring in patients with concomitant pathology in the extrahepatic ducts and those without any such complication.

Reviewing the material at hand, the following figures on sex and age can be presented. In these statistics, the age was not known in four cases (Table II). In 28 males and 27 females, there were:

LIVER STONES

TABLE II

AGE RANGE OF FIFTY-ONE CASES OF LIVER STONE

13 years	— 1 case	} 33%
18 years	— 1 case	
20 to 30 years	— 5 cases	
31 to 40 years	— 10 cases	
41 to 50 years	— 17 cases	} 33%
51 to 60 years	— 7 cases	
61 to 70 years	— 5 cases	
71 to 83 years	— 5 cases	

Two-thirds of the cases were over 40 and one-third over 50 years of age. Collection of statistics as to the ratio of profession, occupation and mode of life was difficult due to incomplete histories, but we were able to collate the frequency of incidence of the process due to type of nourishment as stated by the Japanese and Chinese.

TABLE III

DURATION OF THE DISEASE IN THIRTY-EIGHT CASES

Under 1 year	— 6 cases
From 1 to 3 years	— 9 cases
From 4 to 6 years	— 4 cases
From 7 to 10 years	— 3 cases
From 10 to 15 years	— 7 cases
From 15 to 20 years	— 5 cases
From 20 to 30 years	— 4 cases

Over 50 per cent had a long duration of the process and in only a small percentage of cases was the disease of recent origin (Table III). In a number of instances, the history stated only that the disease had been of long duration, without specifying the exact time.

The symptoms complained of upon admission are the same as those of cholelithiasis. The most frequent are pain, jaundice, elevated temperature and tumor, or enlargement, in the right upper abdominal quadrant; and, more rarely, dyspeptic disturbance and inanition.

Pain.—Occurs most frequently in the form of attacks of rapid onset and of more or less long duration. Treatment relieves the pain only in rare instances. As the process develops, the frequency and continuance of attacks increase in number and intensity. After a long interval, the characteristic clinical picture of a severe cholangitis, liver abscess or sepsis, may suddenly present itself. In 10 per cent of the cases a dull pain remains after an attack.

In exceptional cases there was no pain at all and a clinical picture of the condition was masked by other symptoms and hepatolithiasis was excluded. Cases are known where the pain radiated to shoulder and scapula. In some cases, the pain was concentrated in the epigastrium for a long period of time, being intense and severe enough to drive the patient to operation.

Temperature.—In the majority of cases, and with very few exceptions, the temperature is elevated. The usual temperature, as seen in cholelithiasis, is present, but changes in relative proportion to the pathologico-anatomic change in the liver, such as purulent cholangitis, liver or other abscesses, and pleurisy. Not less than 25 per cent of the cases were accompanied by chills.

In some rare cases, the temperature is not elevated at all (Kenelm, Digby, Eickhoff and others) or is subnormal. In some instances, the temperature, after being normal over a period of months or years, ran a typically septic course, which predicated a complication or a progression of the disease.

Jaundice.—The majority of cases are accompanied by jaundice. If it is absent upon admission, the past history in many instances will reveal its presence sometime during the patient's illness. It is most frequently an obstructive jaundice. The autopsy confirms the closure of the common duct. After proper drainage of the ducts, the jaundice usually became less or disappeared entirely. In some cases, however, it did not disappear at all after draining the ducts. The autopsy in these cases divulged closure of the intrahepatic ducts and liver insufficiency. Pruritis, hemorrhages, changes in the urine content and stool, following jaundice, are present in these cases as they are in cholelithiasis.

Gastric Disturbances.—Are observed in the majority of cases. This is due to changes in the secretory and motor function of the gastro-enteric canal. Indigestion or dyspeptic symptoms, anorexia, vomiting during the attacks or sometimes at their termination, definitely connected with time of eating, achlorhydia or hyperchlorhydia, constipation, sometimes diarrhea, are the symptoms which typify the disturbance in the gastro-intestinal canal. Sometimes inanition and anorexia are the early symptoms of a severe liver pathology (case of Eickhoff). Intestinal or pyloric stenosis or intestinal occlusion occurring as clinical symptom complex predicate the presence of adhesions to important adjacent organs (stomach, duodenum, etc.).

Acholic Stool.—Is frequently met with and indicates delayed or obstructed flow of bile. Degree of closure of the biliary ducts, however, will not always run parallel with discoloration of stool. The stool may not be entirely discolored and yet the ducts can be entirely filled with a bile colored, compact mass, or tensely filled with stones; or conversely, the stool may be discolored and the ducts may be apparently and relatively patent.

The passage of stones in the stool was observed only in isolated cases, which in reality would have been seen more often if the patients had examined their stools more frequently.

Liver.—The liver is either found enlarged upon admission of the patient; enlargement is stated in the patient's history; or it is found at operation or autopsy. Sometimes, prior to operation, notwithstanding its diseased condition (jaundice) the result of liver function tests will be found normal. In a number of cases (Beer) the liver was accepted as normal. However,

it could only have been judged by external findings, because the presence of a severe cholangitis would hardly predicate a normal liver.

As a rule the liver is uniformly enlarged, yet in a number of cases, this enlargement was confined only to one lobe or only a part of the liver which, however, reached large proportions. This liver enlargement, or tumor, sometimes forms the essential and only sign when the patient is admitted.

The Gallbladder.—The gallbladder is sometimes enlarged to the size of a fist, or larger, and may reach to the umbilicus. In at least 20 per cent of the cases it was not palpable. Inflammatory reaction in the gallbladder or in its immediate surrounding tissue is accompanied by tenderness and sometimes pain in the gallbladder region.

The Spleen.—The spleen is rarely mentioned in the clinical histories. As soon as septic symptoms appear, the spleen becomes very much enlarged.

The other organs, such as circulatory system, lungs, kidneys and nervous system, not infrequently are involved in the general pathologic process, the symptoms manifested being collapse, shock, spasm, biliary or purulent pleurisy, edema of the lungs and severe forms of nephrosis, nephritis and anuria.

The abdominal wall is sometimes tense, tender and painful. The pain and tenderness, besides other concomitant symptoms, are characteristic of the acuteness of the condition, of liver abscess or the presence of a perforation.

It is apparent that all the above mentioned symptoms do not typify anything characteristic of hepatolithiasis. The same symptoms hold for cholelithiasis. Search for past infection from which the patient has recovered does not accomplish anything. A definite relation or connection of a definite infection from which the patient has recovered in the past, with hepatolithiasis, can never be established. Frequently typhus (*abdominalis recurrens*), rarely malaria and syphilis, will be met with—yet not in any higher percentage of cases than in other diseases, such as we find in the history of renal sclerosis in kidney disease.

With this symptom complex, hepatolithiasis as an entity is rather difficult to diagnose. Roentgenograms may be useful, but, as the case histories show, they are not often taken. In the case of Hawkes, after a cholecystectomy, attacks of pain returning, the films showed the shadow of a stone above the bile tracts. Operation confirmed the roentgenologic interpretations.

Heiser, in 1914, describes two cases where the roentgenogram showed scattered stones in the liver parenchyma besides those in the gallbladder. Matrossow reports a case of recurring pain and biliary fistula a number of months following the opening of a liver abscess which contained a stone. Probing the fistula disclosed another stone in the left lobe of the liver. A roentgenogram also disclosed another stone in the right twelfth intercostal space, next to the eleventh and twelfth vertebrae which was removed by operation. These facts establish the necessity of roentgenologic examination in suspicious and vague cases, especially when there is a recurrence

of pain or reappearance of jaundice postoperatively. No case was correctly diagnosed except those which were examined roentgenologically before operation.

If there was no autopsy after operation a correct clinical diagnosis was not accepted. In some cases it was noted that the operation revealed only the liver tensely filled with stones, the removal of which was impossible, or the liver was nodulated, the nodules containing stones. Frequently, however, the operation failed to establish a correct diagnosis.

In the majority of cases, the diagnosis of complicated cholecystitis, obstruction of the common duct or cholangitis is made. Another group of patients were admitted with an encapsulated liver abscess and enlargement of the liver. This enlargement was almost always an abscess containing stones, or stones were expelled later. Sometimes this enlargement was diagnosed as an echinococcus cyst, or cancer of the liver.

Pancreatitis should be considered in the differential diagnosis in addition to abscess, echinococcus cyst and other various forms of diseases of the bile ducts and gallbladder. The acute and severe course of hepatolithiasis sometimes simulates acute pancreatitis and has been diagnosed as such. More frequently, however, ductal obstruction with atypical symptoms of cholelithiasis presumed the diagnosis of a chronic, indurative pancreatitis which the operation at times confirmed. Pancreatitis has also been diagnosed as the primary disease instead of the complication, which it really is, and the operation was confined to an exploratory laparotomy without any successful result, the subsequent autopsy establishing the true diagnosis. The mistakes in diagnosis are embraced in the above mentioned borderline cases of pathology of the process.

The Japanese offer interesting data concerning liver stones, due to its more frequent occurrence there than in any other country. The Pathologico-Anatomic Institute at Kiuchu (south) cites six cases, nearly all coming to autopsy, coexisting with lesions in the extrahepatic bile ducts. Of these, nearly all were 20 to 40 years of age. The clinical diagnosis of cholecystitis, cholangitis, liver abscess and cholemia came closest to the true diagnosis.

In the Pathologic Institute statistics, at Tokyo (north), the 13 cases of hepatolithiasis cited coexisted with 50 per cent lesions of the extrahepatic ducts. The patients were between 60 and 81 years of age. This group came to autopsy with the diagnosis, before death, of apoplexy, shock and mania, *etc.*

It appears that in these cases the existence of liver stones was not even considered, which can be accounted for by the kidney and heart disease from which a number of these patients died. It is difficult to exclude the hepato- and cholelithiasis as one of the etiologic factors responsible for the damage to the heart, kidneys, blood vessels and nervous system. A connection between these processes, however, is unquestionable.

These data allow us to establish a schematic set up of two groups in the clinical course of the process. In the first group, we placed cases with

a relatively rapidly developing liver insufficiency in people who are not old, or a virulently active infection with exitus from gallstone disease during middle age. In the second group, in most cases, the liver insufficiency does not appear before 60 to 80 years of age and the infection, if it does occur, is not severe and does not assume a virulent form. In consequence the patients die of damage to other organs. The pathologic changes of the diseased liver, the infection of the bile passages and the toxemia, although probably playing an important rôle, were not considered immediate causes of death. Cholemic bleeding was not met with in these cases.

Diametrically opposed in their course and clinical picture, we find patients in our collected cases, as for instance Case III or in Fedorow's cases of the 13 and 23 year old patients, Case V, where very marked liver changes and a stormy course presented an entirely different syndrome when compared with that noted in the 65 year old patient reported by Beer where the first symptoms of gallstone attacks occurred only four weeks prior to consultation or that in a 79 year old patient where gallstone attacks were absent and the patient rapidly died from sepsis, in whom the autopsy showed the presence of a great number of stones in the bile ducts and in the liver with definite and marked changes in the latter.

TREATMENT AND CAUSES OF DEATH.—Out of 57 cases, 41 were operated upon.

TABLE IV
TYPE OF OPERATION PERFORMED IN FORTY-ONE CASES

	Cases
1. Inspection or aspiration of gallbladder.....	2
2. Gallbladder fistula.....	10
3. Cholecystectomy.....	18
4. Choledochotomy.....	18
5. Hepaticotomy.....	3
6. Cholecystogastrostomy.....	1
7. Cholecystoduodenostomy.....	1
8. Hepaticoduodenostomy.....	0
9. Opening liver abscesses.....	5
10. Removal of liver stones.....	7
11. Opening dilated cystic duct stump and removing stones.....	1
12. Section of scar and fistula.....	3
13. Gastro-enterostomy.....	1
14. Fistula of the cecum.....	1
15. Opening lung abscess.	1
16. Incision of subdiaphragmatic abscess.....	1

This table shows that the most frequently performed operations are cholecystectomy (18 cases); choledochotomy and hepaticotomy (21 cases), and twice less frequent is a cholecystostomy with establishment of a gallbladder fistula (10 cases). In 12 cases, a liver abscess with stones was opened, or a portion of lithiac liver tissue was resected, including its stones. In 32 cases, gastro-intestinal anastomosis with the bile ducts was done. Other

procedures, such as opening up the stump of the cystic duct, or resection of scars, opening and resection of fistulae were resorted to at secondary, or repeated operations. Gastro-enterostomy; establishing a fistula at the cecum and rib resection, were operations of necessity indicated by complications. In two cases of Miyake, the hepatolithiasis was not recognized at all at operation, the surgeon confining himself only to inspection and incision of the gallbladder.

Two cases were reoperated on and in the one inspection of the abdominal cavity revealed a hernia which had developed from the first operation for the removal of stones. There were no visible changes in the region of the bile ducts (Büdingen). In the second case (Körte), a cholecystectomy with drainage of the cystic duct had to be done six weeks after a cholecystostomy with fistula had been performed, and one-half year later a choledochotomy with drainage was done on this same patient.

After seven cholecystectomies, two of which were accompanied by choledochotomy, three operations of entero-anastomosis had to be done, one year later in the case of Rufanov and one and one-half years and ten years later in the case of Terebinskij. Twice, after two and after six years, Hawkes and Kadjan opened the liver to remove stones, and in one case a second choledochotomy had to be done after four months for the removal of a newly appearing stone. In one case stones were removed through the unhealed, biliary fistula (Kahiske). In another case, gastro-enterostomy for pyloric stenosis was performed; three years after the first operation and eight years later a fistula was made in the cecum because of adhesions threatening intestinal obstruction.

In the case of Jukelson, an abscess in the epigastrium was incised first and this had to be followed by drainage of the subdiaphragmatic space and finally, by cholecystectomy and choledochotomy.

It is striking how the number of relaparotomies is definitely more frequent in hepatolithiasis than in cholelithiasis. This is partly explained by the severity of the liver stone pathology and also by not recognizing the existence of liver stones at the time of the operation on the gallbladder and particularly, in the latter instance, by the short period of drainage, precluding a good end-result.

The most important question of the expediency of the operative procedure adopted and the errors made while operating, can be answered by a review of all the material subjected to surgery. This may be divided into three groups:

- (1) Cases which were cured.....15
- (2) Cases which died.....25
- (3) Cases which came to autopsy without any operation.....15

The easiest cases to cure were in the first group. Late results are not reported because probably there had not been a complete cure. First, all the patients were relatively young—two-thirds were not over 35, and only

one patient (Barth)⁴ was 54 years old. In this case, the fistula, after a choledochotomy, was still draining after 13 months. Flushing the fistula and bile ducts caused many stones to be expelled, after which the fistulous tract closed rapidly. Second, the duration of illness was shorter than in the second group. In 40 per cent, the condition did not continue over three years and in 25 per cent less than one year. Third, the clinical picture was usually different than in the second group. In 80 per cent of the cases there was a circumscribed process. In five cases the operation consisted of abscess incision, and in three cases stones were removed, with a resection of a portion of the liver parenchyma. In one case there was a congenital absence of the gallbladder and by choledochotomy and draining the common duct the patient was saved. Three cases were so called "fresh" cases, presenting, so to speak, the first step in the formation of solid stones (Büdinger¹⁰) which the author also emphasized in a third, analogous case in which, however, the general condition was too far advanced and the patient died.

The twelfth case (Kenelm¹¹) was a 34 year-old patient whose first attack dated back nine months. Drainage of the gallbladder ducts and removal of stones definitely settled the operative result. The presence of white bile, enlargement of the liver, *etc.*, is a definite confirmation that the operation is performed at the right time. Finally, in the thirteenth and fourteenth cases (Kadjan and Terebinskij^{34, 55}) there was a long interval between the first and second operations, during which time the patient felt well (ten and six years). In Terebinskij's case, the operation showed a kinking of the hepatic duct containing an intrahepatic arborized stone, involving the hepatic as well as the common duct. It is quite clear that the stones existed before the first operation. Their slow growth can be explained by displacement of the bile duct which occurred by the formation of scar tissue in the surrounding tissue after the first operation.

In the very interesting case of Kadjan, after the first radical operation of cholecystectomy and choledochotomy, there ensued a period of six years of complete health. At the second operation, performed because of colic, jaundice and acholic stools, another choledochotomy and removal of stones from the common, as well as the hepatic duct, was done. The surgeon was able to palpate a deeply lying stone which he was able to remove after opening the liver with a Paquelin cautery. This stone could easily have been overlooked and the results of the operation would have been different.

All cases of cure as related to the time of operation were of short duration.

Surgery of the bile ducts only began to develop 40 years ago and rapidly advanced during the first and second decades of the twentieth century, to the status of development it enjoys today. During this time, countless thousands of gallbladder operations were done. Experience thus gained, as we can perceive in the second and third groups (Mermann³⁶) expressed itself in the indications for the operation and in the operative technic itself.

It will be noticed that these groups show a very large percentage of patients with liver stones, without, however, any pathology of the gallbladder or bile ducts. This brings about a greater difference as a result of treatment.

In the majority of cases, simple surgical procedure, in the first group, was sufficient to bring about a good result. This was due to the relative youth of the patient, the short duration of the illness, the limited extent of the process and the absence of general damage to and insufficiency of, liver parenchyma and tissue, as well as other parenchymatous organs (kidneys); and finally, the absence of any inflammatory process in the bile ducts and capillaries (cholangitis and cholangioitis). This we were able to observe in the next group. We were unable to ascertain the length of time of cure with definite certainty in a number of cases. Observation was not made over a long period of time in some cases. Recurrent, or rather, progressive development of the pathology, without doubt, went on unchecked.

Twenty-five cases, with autopsy shortly after the operation, belong to the second group. These were protracted cases, with severe clinical and pathologico-anatomic changes in the liver and other organs. The patients in this group, as compared with the first, were very much older. Although we find only one case at 50 years in the first group, we find only three patients in 25 cases under 50.

One case presented the picture of a fully developed, intense form of frank liver insufficiency with general kidney symptoms and at operation all the stones could not be removed. Another patient had ten attacks during the course of two years. Some of these attacks began with chills and lasted two months. Operation showed an intact gallbladder and extensive changes in the liver, as well as the pancreas, the insufficiency of the latter causing the patient's death, 18 days later.

In the third case, that of a 13 year old boy, the attack began at three years of age. The findings at operation were, a thickened mass, tensely filling the intrahepatic and extrahepatic bile ducts, with a mixed infection of *B. coli*, *B. perfringens* and diplococci, complicated by a purulent diplococcus pleurisy. All the other patients, however, were between 50 and 60 years of age.

The duration of the disease in this group was decidedly longer than in the first. We find patients with 15, 25, to 30 years' duration of the disease suffering from repeated attacks of severe obstructive jaundice, infection in the bile ducts and enlargement of the liver. Individual cases where the duration of the disease did not exceed two to four years accompanied, however, with complications in the liver (cholangitis, cholemia) as well as those of other organs, were seen.

The clinical picture is much more severe than in the first group. Due to prolonged duration of the disease, it will definitely manifest itself before operation. These patients were admitted in a septic condition, with cholemic changes of the kidney, *etc.*, and at times it was found during the operation that all the stones could not be removed.

We found 80 per cent of the cases in the first group with a circumscribed process without any involvement of the extrahepatic ducts, while in 90 per cent of the second group we found coexisting gallbladder and liver stones. In only two cases was the process entirely confined to the liver. In both these cases, the operation was only exploratory, the autopsy revealing a purulent cholangitis and liver abscess.

A certain number of operations in this group really belong to the early period of gallbladder surgery when the indications for operation were approached with greater caution and choledochotomy was attempted only in occasional cases. It is easily understood why the operative procedure, as for instance in the two step operation, in the presence of angiocholitis and stones in the ducts, sometimes proved insufficient. Such errors, however, were few and can be observed in only three patients.

The causes of death in this group were as follows: In two cases, death did not follow immediately after the operation. One was an instance of obstruction of the bowel from adhesions, in which case a fistula was established. The other was a case of lung abscess in an old, cachectic patient, in whom a rib was resected. Probably the lung abscess, as well as the intestinal adhesions, were etiologically connected with the original disease. In the other 23 cases, the following causes of death existed: (1) liver insufficiency, 16 cases; (2) purulent process (angiocholitis and liver abscess, 7 cases).

Death followed very shortly after the operation which is easily understood when one analyzes the essential causes of death and their result, namely—liver insufficiency, cholemia (Kenelm¹¹); gastric hemorrhage (Oehler⁴⁰); convulsions (Büdinger¹⁰); soporific condition with semicoma (Harper); postoperative "liver coma" with absence of bile drainage; appearance of white bile; ascites (Kehr and Kenelm), and necrosis (Rufanov).

In all the cases, the bile ducts, up to their most minute branches and arborizations, were completely filled with stones in a chain or tandem-like, compact, clay colored mass. In a number of cases not all the stones could be removed at the operation, so that it was really only exploratory (Haberer,²¹ Rufanov^{46, 47, 48}). In cases coexisting with cholangitis, although the clinical picture of liver insufficiency was present, the infection was overwhelming.

Besides liver changes, cases of coexisting kidney degeneration, anuria (Rufanov and Haberer), perforation of the gallbladder and circumscribed purulent peritonitis, leading to gastric, omental and intestinal adhesions; sometimes a septic condition (Rufanov), embolus and infarct in various organs (Kaliske²⁶), were seen.

We place cases not operated upon, but autopsied, in the third group. They were 15 in number. In two, the stones were found only coincidentally (Hesse¹⁸ and Beer⁵). In one, the history was not known. The other cases were mostly all 60 to 80 years old and had undergone a prolonged internal and mineral spring treatment. They were admitted with signs of severe cholangitis, liver or subdiaphragmatic abscess, ulceration of the gallbladder or bile ducts following a long continued lithiasis and infection, as well as

cholemia, hemorrhage, sepsis or collapse. We were dealing with neglected and prolonged cases of cholelithiasis with duct obstruction which had not been operated upon at the proper time. Some of these patients presented the clinical picture of a rapidly (four to five weeks) developing, purulent cholangitis following a long continued, sometimes symptomless lithiac disease which, proved by autopsy, could only have existed for years.

It is unquestionable that in the beginning of today's modern surgery, the absence of definite physiologic reasoning for diagnosis, indication for operation, prognosis, and the undeveloped state of surgery, as well as the long continued confidence in all other therapeutic measures was the reason the cases in this group were not operated upon earlier.

Forty patients out of the 55 died, a mortality of 75 per cent. One notices that there is a marked difference in the course of the condition when dealing with extrahepatic duct stones with coexisting liver stones, or in cases of liver stones existing alone. First, in 26 cases with coexisting liver and gallbladder stones and stones in the large bile ducts, we find five cured. Second, in 18 cases of stones in the liver, coexisting with stones either in the bile ducts or only in the gallbladder, we find three cured. In one of these cases the gallbladder was absent. Third, in 11 cases of liver stones existing alone, seven cases were cured. One was not operated upon at all, and two were not even treated.

If we compare the third group, we find that the patients with unfavorable operative result (second group) as well as those not operated upon who died, form nearly an equal quality group which is sharply defined from those of the first group who have recovered from their operation.

CASE REPORTS

CASE I.—(Rufanov). Thirty-five year old female, admitted December 25, 1922, complaining of constant pain in half of the right upper abdominal quadrant, increased after eating. Six months previously suffered an attack of diarrhea, epigastric pain, with vomitus of bile, chills and feeling of chilliness with a temperature rise to 38.0° C. which dropped to normal in ten days, leaving her generally weak. The pain increased steadily, added to which she suffered from pyrosis and eructations. Upon admission, a movable, hard mass about the size of a fist was palpable in the right hypochondrium. There was a gastric subacidity.

Operation.—January 30, 1923. The liver was irregular in shape, the right lobe reaching into the pelvis, the left lobe presented an unusual incisure and an accessory lobe, 3 x 3 cm. in size which was suspended from its under surface. To the left and 1 cm. above the edge of the liver there was a white, scar-like spot, 2.5 x 2 cm. in size, which, upon incision and resection, proved to be a thin-walled cavity containing stones. A second cavity filled with stones was palpated on the under surface of the liver. Opening this cavity showed that it extended 6 or 7 cm. perpendicularly from the free edge of the liver into the liver tissue itself, while the left branch showed cavities which also contained stones. Resection of liver parenchyma, 6 x 10 cm. in size, and including the cavity containing stones, was done. To the right, and also in the remaining portion of the liver, no changes were found. The denuded surface was sutured.

During the postoperative period there was long continued pain and vomiting. Pathology of the liver tissue showed scar tissue changes, the liver containing many

stones. Microscopically, the dilated bile tracts contained bile pigment, the ducts surrounded by proliferated connective tissue. The stones were dark brown in color, of polyhedral shape and pulverized easily. Their chemical content (Prof. W. S. Gulewic) consisted of calcium combined bile pigment (cholesterin, bilirubin) and magnesium salts (Fig. 1).

CASE II.—(Rufanov). Male, 40 years old, admitted March 4, 1929, with pain under the right costal margin, radiating to the right scapula. History of syphilis having been contracted 15 years prior and a recurrence one year previously. The pain beneath the rib margin had begun suddenly 12 years previously, with a temperature of 40.0° C. which continued for three or four days. Similar attacks always recurred after doing heavy work, sometimes coming on twice daily. At times he was free from these seizures for three to four months. About one year before admission, had a sudden and especially severe attack with coma and a temperature of over 40.0° C., accompanied by severe pain, radiating to the right scapula. This attack continued for three weeks. His temperature fell, followed by jaundice which remained for 15 days. The patient was confined to bed for four months. After this the attacks recurred following any heavy work or severe physical labor. Jaundice, however, did not recur.

Examination.—Pulse, 72; accentuated heart sounds. Blood examination: Hemoglobin, 85; erythrocytes, 4,300,000; leukocytes, 7,000; coagulating time, two and one-half to three minutes; blood clot, 7 min. Urine examination: urates and isolated leukocytes. The liver was located two fingerbreadths below the right costal arch. The gallbladder was tender on palpation. The roentgenogram showed the outline of the gallbladder, definitely and continuously located on the level of the fourth lumbar vertebra. Gastric secretion showed a total acidity of 50 and free acid 30. Gallbladder reflex not present.

Operation disclosed an atrophic gallbladder, adherent to the pylorus and pyloric end of the stomach. While separating the adhesions from the liver, the gallbladder was accidentally opened and three stones, 1 cm. in diameter, were removed from it. Many stones were felt in the common duct and were removed in great numbers with a spoon. They not only filled the common duct, but also the right and left hepatic ducts. The common duct was drained, plus tampon drainage. There was a copious amount of bile drainage during the postoperative period. Enemata showed normal colored stools. General condition of patient satisfactory. The right lung showed an inflammatory process. The eighth day after operation the patient died.

Autopsy showed marked dilatation (about 4 cm.) of the common duct, with roughened and injected mucosa containing small, soft gallstones and mucus. The hepatic duct also was dilated. The liver was of usual size, flaccid and when cut showed evidence of isolated, red, healed, regeneration foci. The lumen of the large as well as the small bile ducts contained stones throughout, which upon section showed a light yellowish color. The pancreas was not especially altered. There was jaundice, a nephrosis, bilateral pneumonia and hyperplasia of the spleen.

CASE III.—(Rufanov). A 60 year old tailor, admitted September 14, 1929, with symptoms of epigastric pain, constipation and general jaundice. Ten years before, he had had typhus (spotted) fever of the abdominal type. Four years prior he had had malaria and measles. Two years before he had had intense epigastric pain, with nausea, vomiting and temperature of 38.0° C., the attack lasting four to five hours. Operated upon in January, 1928, for the first time, at Charkow. A cholecystectomy was done, the gallbladder containing stones. The patient was discharged in four weeks, feeling well. After nine months the same type of attack returned, accompanied by clay colored stools and general jaundice. Duodenal intubation resulted in a small degree of improvement. Treatment at a health resort afforded no relief. Lost 29 Kg. in weight.

Condition upon Admission.—Icteric sclera, acholic stool, eructation, nausea and vomiting. Dull heart sounds—rough breathing. Hemoglobin, 75; erythrocytes, 3,800,000; leukocytes, 7,400; blood coagulation time, two minutes and 20 seconds to three minutes;

blood clot, 8 min. Urine: urates and occasional leukocytes. Lower edge of liver two fingerbreadths below edge of rib curvature and the liver was tender on palpation. Total gastric acidity 94. Free hydrochloric acid, 66. *Direct* positive bilirubin reaction; diastase in urine; after eating mild marjoram—64.

Second Operation.—Anesthesia, morphine-chloroform-ether. Mobilization of duodenum. Opening common duct close to the duodenum from which flowed golden bile accompanied by a number of stones. Probing the duct upward and downward showed it to be unobstructed. A drain could not be inserted, however. Anastomosis between the common duct and the duodenum was done. Tampon drainage was instituted.

During postoperative period, intestinal paresis with singultus lasting a number of days occurred. There was a very copious bile drainage.

A third operation was performed in which a drain was placed between the duodenum and the common duct. Sutures were applied over the drain. This was done on the fifth day after the second operation, because of separation of the edges of the choledochoduodenal anastomosis. Severe singultus continued, the patient losing in weight and vitality with only occasional lessening of jaundice. The patient died 17 days after the first operation.

Autopsy.—Ulcer of the lesser curvature of the stomach, the size of a 20 kopeck piece. The edge of the ulcer was undermined and had a small bloodvessel coursing across its floor. Scar at the common duct. The drain lay next to the hepatic duct and entered the ampulla of Vater, passing into the duodenum. The liver was of usual size, flaccid and spotted here and there with bright yellowish colored, fibrous layered necrotic areas.

Large, as well as small intrahepatic ducts were markedly dilated containing an accumulation of small, soft, dark-brown stones. There was jaundice, kidney and biliary cirrhosis. The duodenal fistula at the site of the separated anastomosis presented incisura and indentations directed toward the ileocecal region. The splenic pulp, as well as the portal nodes, were hyperplastic. Dilatation and degeneration of the heart was present. There was an emphysema of the lungs and fenestrated aortic valves.

CASE IV.—(Rufanov). Woman, aged 52. Admitted November 21, 1925, with signs of a lung abscess on the right side. Since the age of 35, she had had periodical, severe attacks of pain beneath the right curvature of the ribs, with temperature rise and vomiting. Had contracted syphilis at 35. Had had six healthy children. For one and one-half months, the lung manifestations consisted of: chills, temperature of 40° C. and foul-smelling expectoration. The spleen was enlarged, the urine contained kidney epithelium, leukocytes, erythrocytes and cylindroid casts. Hemoglobin, 65 per cent; erythrocytes, 3,900,000; leukocytes, 15,400. The sputum showed elastic fibers, streptococci and diplococci. There was positive dullness over the lower lobe of the right lung.

Operation.—Resection of the seventh, eighth, ninth and tenth ribs, followed by opening of a lung abscess. Wound tamponed. Patient extremely weak. No drop in temperature or improvement. Patient died 17 days postoperative.

Autopsy.—Septicemia. Abscess of right lung. Degeneration of heart and liver. The common bile duct was dilated and obstructed by a stone. All the bile ducts were completely filled with a granular, crumbly, brittle mass of formed gallstones.

CASE V.—(Fedorow). February, 1926. A 23 year old female, ill two years. First attack lasting one and one-half weeks, characteristic of a liver colic with radiation to right scapula and accompanied by jaundice. Several months later she had a second attack, lasting two weeks. Since this time she has had attacks nearly every month. In August, 1927, she had her tenth very severe attack with chills, rise in temperature and jaundice, lasting two months. After two months there was a recurrence of the jaundice. The enlarged liver and gallbladder could be palpated. Phrenic symptom not positive.

Operation.—January 18, 1928. Incision according to Kehr. A somewhat dilated gallbladder with adhesions of the omentum to the under surface of the liver was found. Adhesions freed, no stones in the gallbladder. Hepaticoduodenal ligament was edematous

and the pancreas was enlarged. Cholecystogastrostomy was done. Postoperative history showed no improvement. Death.

Autopsy.—Enlarged pancreas. No stones in the gallbladder or hepatic duct, yet the liver itself contained an extraordinarily large number of stones in its intrahepatic ducts.

CONCLUSIONS

Contemplating the operative result, as well as the cause of death, we find that early operation performed during middle age or youth, on the extrahepatic ducts, will offer the best end-result for a positive cure, and, conversely, neglected and prolonged cases in advanced age with protracted illness, with intercurrent or secondary pathology of other organs, offer the greatest likelihood of failure. The percentage of cures can be high only if the process is circumscribed in the liver or if there are no changes in the extrahepatic ducts.

The treatment of solitary and multiple liver abscess, although analogous, is diversely different in operative result. In the first instance, the result of incision of the abscess and good drainage is definite and certain. In the second, however, even drainage is most often found to have been done too late.

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TRUE PROLIFERATING CYSTIC LYMPHANGIOMA OF THE MESENTERY

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CYSTS of the mesentery are undoubtedly among the rarest tumors encountered in the field of general surgery. In most text-books, the condition is not even mentioned; or, if mentioned, it is dismissed with a few brief words. Collins and Berdez¹ report that not a single case of chylous cyst was found in 15,000 necropsies at the University of Minnesota, and that in 200,000 cases at St. Mary's and St. Luke's Hospitals in Duluth, only two cases of chylous cysts were found. Alesen² was unable to find any cases of mesenteric cyst at the Los Angeles General Hospital during the years 1912 to 1929. Writers disagree on the number of cases of these cysts recorded in the literature, usually stating the number to be between 200 and 400. From a careful search of the literature, I was able to find approximately 500 cases of mesenteric cysts, while true proliferating cystic lymphangiomas I have found to be remarkably uncommon. The literature contains only ten cases wherein both the gross and microscopic descriptions will allow of such a diagnosis. Many cases are erroneously reported as cystic lymphangiomas, that in reality are typical enterocystomas, and some multilocular mesenteric cysts are recorded that fail to show any proliferative changes. Because of the infrequency of true proliferating lymphangiocystomas, it seems to me that the following case is worth recording.

CASE REPORT

G. G. W., male, aged 43, a farmer. On August 21, 1934, he complained of pain in the left upper quadrant. This became gradually worse. Pulse 70, temperature 97.8° F. Abdominal examination revealed nothing except an increase of pain on deep palpation on the left side. There was no rigidity. Repeated hypodermics of morphine were necessary in order to control the pain. There was some nausea but no vomiting. No history of constipation or diarrhea. The following two days, the pain was persistent and of a dull character with no radiation. On the third day of his illness, a firm mass about the size of an orange was palpable in the left lower quadrant, medial and inferior to the iliac crest. Temperature 99.8° F., pulse 76. During the next few days the mass increased steadily in size until it reached the umbilicus and seemed to be centered in the left midline of the abdomen. The tumor was firm and apparently smooth. During this period of observation, the temperature never exceeded 101° F. and the pulse was never over 86. There were no other gastro-intestinal symptoms at any time, and the patient had a normal bowel movement each day.

On the fourth day of his illness he entered the hospital. On physical examination, the findings were practically the same as have already been stated. In the left lower quadrant there was a mass about the size of a grape fruit. It was firmly fixed and slightly tender on palpation, no nodules could be felt, nor could a notch be demonstrated. All the borders were apparently free, and no definite attachment could be

made out. Roentgenographic examination revealed an homogeneous density in the abdomen to the left and downward, and the small intestine lay downward and to the right. A barium enema showed the sigmoid displaced downward and to the left by a mass. No definite filling defects were present in the colonic walls, nor were diverticula demonstrable. The mass was too far to the left for the usual appendiceal abscess. No unusual irritability of the sigmoid was found to suggest ulceration or perforation. Leukoeytes 13,900 with 82 per cent polymorphonuclear neutrophils. The urine and blood chemistry were essentially normal. The Wassermann and Kline tests were negative. The patient's condition improved steadily and he was operated upon on the 17th day of his illness.



FIG. 1.—Photograph of gross specimen showing jejunum opened at the base and large, nodular, hemorrhagic tumor involving the mesentery.

Operation.—Left midrectus incision. A large, red, spongy appearing mass of relatively firm consistency was exposed, which measured approximately eight by six by four inches. In order to mobilize the tumor it was necessary to enlarge the incision in both directions. It was then noticed that there was a torsion of its base in an anticlockwise direction, and that the tumor was apparently involved to the mesentery alone. The mid-portion of the jejunum was overriding the lateral border of the mass so that the latter could not be enucleated; therefore, about five inches of gut on either side of the tumor were resected and a side-to-side anastomosis made.

The postoperative course was uneventful and the patient was discharged 16 days after operation. At the present time, six months after the operation, his condition is normal.

Pathology.—The specimen is a nodular semicystic discolored mass measuring 18 by 16 by 9 cm. There is a section of jejunum bounding the mass along one border and the tumor is growing throughout the mesentery of this section of bowel. The nodulations of the tumor vary in color from a greenish-yellow to a deep blackish-red, and many of them are covered with fine granulations. On section, many of these masses or nodules are cystic and the content of these cysts ranges from clotted blood to a milky semiflocculent material. These small cysts vary in size from .5 cm. to multilocular cavities as large as 6 cm. in diameter, and there is one quite large cavity measuring 12 by 11 by 8 cm. This is lined with a yellowish granular material, and shiny, pale, grayish-white nodulations not much larger than a pinhead are found in clusters here and there on the wall (Fig. 1).

Histologic Pathology.—Sections taken from different areas reveal varying sized cystic cavities, many of which are lined by quite flattened endothelial-like cells. The content of these cavities ranges from a pink staining albuminous precipitate to a frankly hemorrhagic type of material. In the wall of many of these cysts there is fresh hemorrhage, and in some definite fibroblastic type of granulation tissue is seen. Lymphocytes are found in abundance; and occasionally, imbedded within the walls or intervening septa, rather large accumulations of lymphoid tissue are encountered (Figs. 2, 3, and 4).

Diagnosis.—Multicystic proliferating lymphangioma of the mesentery showing a receding inflammatory reaction.

The first case of mesenteric cyst was reported by Beneviene in 1507 as an anatomic curiosity. Various writers have subdivided the history of mesenteric cysts into years as follows: Thus, from 1507 to 1850, this type of tumor was encountered only accidentally at necropsy, while from 1850 to 1880 a few tumors were occasionally observed at operation. In 1880, Tillaux recorded the first operation for this condition, and from this time until 1900 there were only a few recoveries following surgical interference. From 1900 to the present time is the last epoch, in which we find detailed pathologic classifications, perfected surgical technic, many recoveries following operation, and an occasional preoperative diagnosis.

Rokitansky is credited with the first accurate description of a chylous cyst in 1842. This writer attempted to prove the origin of mesenteric cysts from degenerated lymph nodes, with which explanation Virchow agreed in 1887.

The first classification of mesenteric cysts was presented in 1892 by Bracquelay.³ His classification included the following groups: (1) Saguinous and serous cysts. (2) Lymphatic cysts. (3) Parasitic cysts. (4) Cysts of adjoining organs. In 1897, Moynihan⁴ presented a classification based on the character of the cystic contents, which unfortunately added little to our understanding of this interesting group of tumors. In 1900, Dowd⁵ stressed the embryologic origin of these tumors and presented a series of cases collected from the literature. He classified the tumors as: (1) Embryonic cysts; (a) dermoid; (b) serous; (c) chylous; (d) hemorrhagic; (e) enteric; (2) hydatid cysts; (3) malignant cystic disease. Subsequently, many writers have attempted to elaborate on Dowd's classification. One of the earlier improvements was that made by Niosi⁶ in 1907, who further subdivided the embryologic group to include those cysts of intestinal origin which he thought were the result of a sequestration from the gut tract or from the omphalomesen-

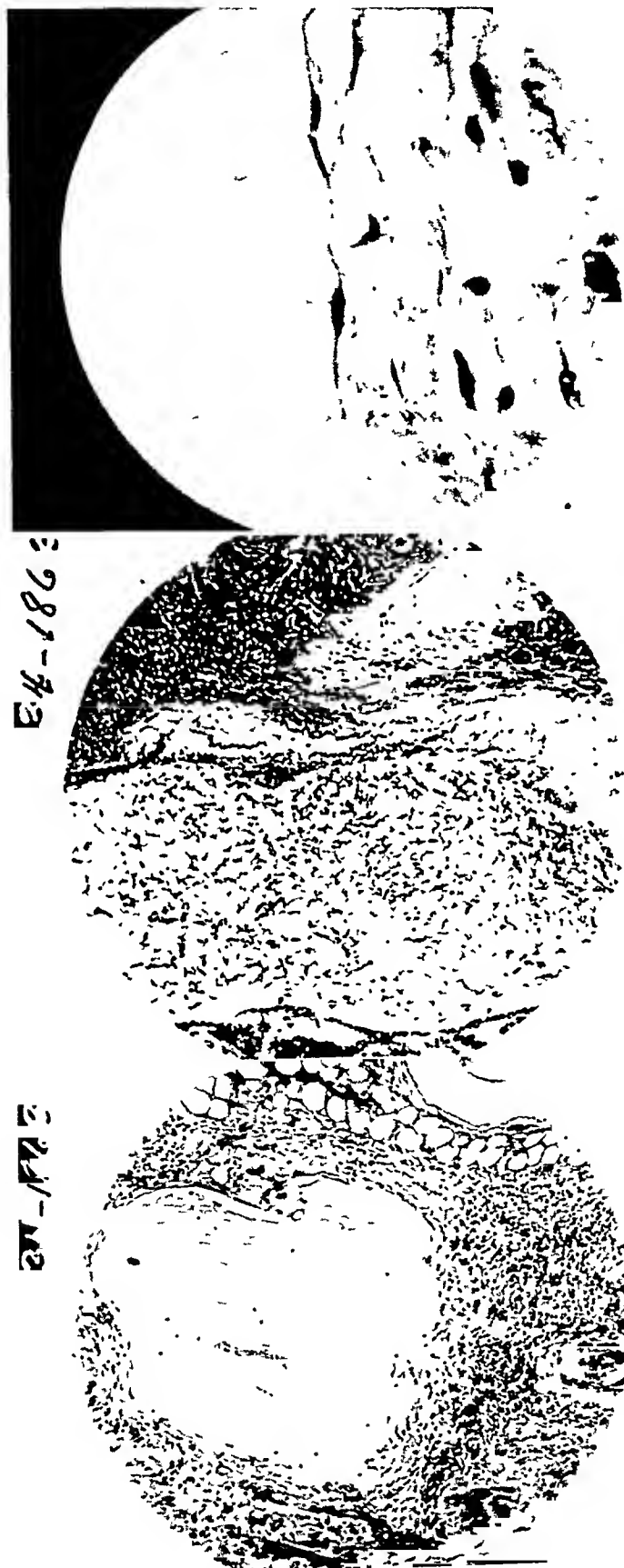
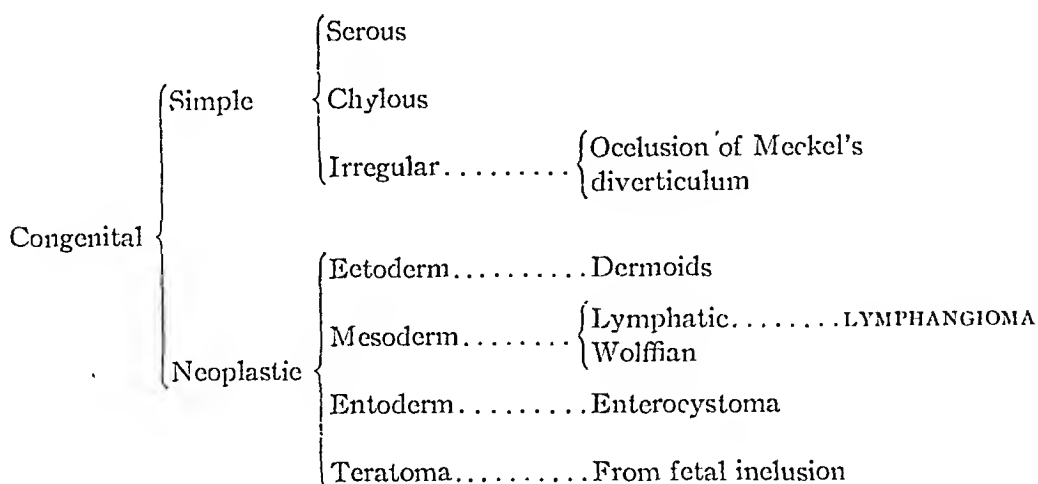


FIG. 2.—Low power photomicrograph showing one of the small lymph spaces filled with lymph; note in filtration of lymphocytes in the wall.

FIG. 3.—Low power photomicrograph of abundant accumulation of lymphoid cells in the stroma of the tumor.

FIG. 4.—Oil immersion photomicrograph of the flattened endothelial lining of one of the lymph spaces in the tumor.

teric duct. Hill,⁷ in 1930, was apparently the first to clearly differentiate the true proliferative lymphangiomata from mere dilatation of lymph vessels and he presents an excellent modification of Dowd's classification as follows:



Since many writers apparently disagree on the exact definition of the term lymphangioma, it is assumed in this discussion that the word is synonymous with a true neoplastic process involving the lymph vessels, with their endothelial cells and supportive connective tissue, in contradistinction to a simple dilatation of preexisting lymph vessels. The latter should be considered as lymphangiectasis and not as a true neoplastic process. Apparently a large number of cases of lymphangiectasis are reported in the literature under the erroneous classification of lymphangioma.

In reality the term mesenteric cyst covers too broad a field. Any condition found in the mesentery and presenting any cystic characteristics whatever is usually classed as a mesenteric cyst. This should not be so. The term is correct insofar as the location is concerned, but it is very misleading from a clinicopathologic standpoint. Very frequently, when considering conditions of a rare and obscure origin, the classification and terminology found in the literature are as unsatisfactory and diverse as the many attempts to explain the process. This is especially applicable to true lymphangioma of the mesentery.

Pathogenesis.—Many theories have been advanced in an attempt to explain the presence of lymphangiomata and cysts of the mesentery. As was previously mentioned, the first reference to these tumors was made by Rokitsky whose opinion was supported by Virchow. They held that these cysts were due to degeneration of lymph nodes. The theory of stasis and retention of lymph in preexisting lymphatic vessels has been advocated by some of the earlier writers. Other authors have attributed these cysts to obstruction of the various lymph channels (Killian, Bramann, Tilger and Hlava, quoted from Hertzler⁸). This theory is certainly untenable because of the existence of many and very extensive anastomoses of the lymph vessels where they do occur. The experimental work of Hertzler⁸ showed only a peritoneal exudate after complete ligation of the thoracic duct. Dowd⁵ also

states that lymphatic cysts do not occur after complete obliteration of the thoracic duct.

Dowd⁵ pointed out in 1900 the close relationship between the wolffian body and the genital ridge to the root of the mesentery in fetal life; and he showed that it was possible during this period for a sequestration of cells from the germinal epithelium to become displaced and assume an intramesenteric, mesocolon or mesorectum position. Later in life, such a group of cells may become active and form a tumor. Dowd also pointed out the further possibility of such a sequestration of cells from the gut tract becoming dislodged and gaining position in the mesentery, thus forming a tumor of intestinal origin. As stated by Hertzler,⁸ this theory may explain cysts found in certain locations but can not account for all the regions where these tumors are found. Some writers believe that trauma may have some influence in their development, while others are of the opinion that inflammatory changes may be of etiologic significance. Fisher⁹ reports a case of lymphangioma of the omentum, which he considered to be due to a metastatic infection producing lymphangiectasis which later was initiated by an attack of tonsillitis several years previously. Outerbridge,¹⁰ in reporting a similar case, agrees with Fisher that a large number of lymphatic cysts may be of an inflammatory character. Ewing¹¹ states that a chylous angioma is due to either congenital or acquired obstruction to the lacteals, which explanation could undoubtedly account for all except the rare neoplastic proliferative types.

One of the most convincing hypotheses to account for the pathogenesis of these tumors is that which holds that they are due to congenital malformations of the lymphatics. Arzela¹² contends that the embryologic defect is an error in the early formation of the lymph nodes, while other writers believe that they arise from a primary lymphatic analage. Ranvier¹³ has noted such misplaced islands of tissue in the mesentery of his newborn pigs and cats. Moreover, lymphangioma has been found associated with lipoma (Ewing), while Ritschl¹⁴ has found an island of cartilage in an intramuscular lymphangioma.

There are several cases of true enterocystoma erroneously reported in the literature as lymphangioma. The embryologic origin of enterocystomas is well proved. Miller,¹⁵ in an article on enterocystomas, records such a cyst which he observed in a four-day-old infant. The wall of the cyst was in part directly continuous with that of the jejunum, and histologically the cyst wall closely resembled that of the adjacent gut. Palmer¹⁶ also reports a case of an infant eight days old with a mesenteric cyst in the wall of which transverse and longitudinal involuntary muscle was encountered. These cases apparently establish the enterogenous origin by a sequestration during embryonic life.

The exact mode of formation of these tumors may depend on the as yet unexplained phenomena involving the formation of lymph. The question arises as to whether the endothelial cells actively secrete or merely conduct lymph, or whether both functions are included. Adami¹⁷ makes the statement

that endothelial cells under pathologic conditions probably secrete lymphatic fluid.

Symptoms and Diagnosis.—It has frequently been stated in the literature that the diagnosis of a mesenteric cyst has never been made prior to operation. After a careful review, however, I was able to find four cases in whom the preoperative diagnosis was made and proved at operation. Three clinical diagnoses were made by the process of exclusion, and one was made by Parker¹⁸ from roentgenographic studies alone.

There are no definite signs or symptoms which are pathognomonic of mesenteric tumors. Naturally, the outstanding feature of the physical examination is the presence of a palpable mass which may be in any location in the abdomen. Usually these tumors are situated in the lower abdomen, and more often are near the midline. Most writers stress the extreme mobility of the mass, especially in a transverse direction. The reported cases give a most variable history. The usual predominant symptoms are severe pain, flatulence, and signs of obstruction. Frequently, a history of repeated attacks of pain is given, often associated with alternate intervals of constipation and diarrhea. Some writers have stressed cachexia as an outstanding manifestation. Obstructive symptoms are usually due to pressure on the intestinal tract which is flattened out over the mass as a ribbon; or the tumor by its own weight may drag down on the gut, causing obstruction. A change in position of the mass may also easily cause a kink in the intestine. Torsion may likewise cause acute symptoms, as may trauma and infection. It is quite possible for pelvic symptoms to predominate if the tumor is low, thus causing pressure on any of the pelvic structures. The size of the tumor has a most important bearing on the symptoms. Thus, it is easily seen that small tumors may give rise to few if any symptoms. Both of Hertzler's⁸ cases were discovered while operating for other conditions. An attempt at differentiation must be made between ovarian cysts, tumors of the liver, tumors and displacement of the kidney, retroperitoneal and uterine tumors, cysts of the pancreas and tumors of the intestinal tract. Roentgenographic studies should be made in all possible cases, as one of the four preoperative diagnoses was made in this manner. Any diagnosis will, of necessity, be made by a process of exclusion.

Treatment.—The treatment of mesenteric tumors is always surgical, and an acute obstruction may constitute an emergency. In operation for this condition, one has the choice of five different procedures, although only enucleation and resection seem to have any real merit. Drainage, aspiration, and marsupialization are unsatisfactory and can not give consistently good end-results. Drainage frequently leaves a persistent draining sinus, which often requires a resection later. Aspiration was used by the older surgeons but today is wholly unsatisfactory. Marsupialization is also a method to be discarded as obsolete unless used as a palliative procedure when the condition of the patient will not allow further surgical interference. Enucleation is, of course, the method of choice when possible. If the tumor can be completely

enucleated without damage to the adjacent gut, or without too extensive impairment of the immediate circulation, the results may be satisfactory. Only on rare occasions is it possible to enucleate a true lymphangioma. The operative mortality of this procedure has been estimated by Flynn¹⁹ to be about 16 per cent. In a majority of cases, resection is necessary in order to remove the tumor successfully. In the uncomplicated cases, the mortality of this procedure probably runs in direct ratio to the ability of the surgeon. One writer reports a series with a mortality of 60 per cent which seems to be unnecessarily high. No doubt such a high mortality is due in large part to the condition of the patient when operated upon and to complications already present at this time; for example, an absolute obstruction of some duration with a possible complicating peritonitis. In uncomplicated cases, there is no reason why this mortality should be any higher than in the usual run of intestinal resections.

Prognosis.—The prognosis of these purely benign tumors of the mesentery is quite favorable, notwithstanding the many pessimistic views presented in the literature. Any growth which showed any gross or microscopic evidence of malignant change naturally would not come under this benign grouping.

Report of Cases from the Literature.—No doubt there are other cases of true proliferative lymphangioma which have not been reported. Perhaps some tumors of this type already reported have been omitted from this paper but the very meager and inadequate gross and microscopic descriptions would not permit of their inclusion. A number of cases are classified as lymphangiomas which in reality are merely lymphangiectases, and many cases are encountered which are undoubtedly enterocystomas.

(1) The earliest lymphangioma was reported by Weichselbaum²⁰ in 1875. The tumor resembled a lipoma and was located high in the ileum, between the leaves of the mesentery. The gross and microscopic descriptions are excellent. The tumor was found at necropsy.

(2) Flynn¹⁹ reports a case of a white girl, aged 16, admitted to the hospital acutely ill, with a history of abdominal pain, nausea, and no bowel movement for three days. The patient had cramping pains associated with nausea for several weeks before admittance. There was a history of a severe blow in the left lower quadrant about six years prior to this illness. One year previous, it was noticed that the abdomen was enlarging. At operation a mesenteric mass was found just below the ligament of Treitz, in the upper part of the jejunum. The size of the tumor was 20 by 12 by 12 cm. and was of a spongy consistency. The tissue cut with little resistance, and consisted of numerous cystic spaces. Microscopic examination showed numerous channels of varying size. Between the channels there was considerable connective tissue, showing lymphocytic infiltration. The channels were all lined with endothelium. Operation—resection with 40 inches of gut. End-result—recovery.

(3) Royster²¹ reported a case in a boy 13 years of age. There was a marked hyperplasia of some of the large lymph nodes, in addition to the

primary growth. The mass was resected along with 54 cm. of gut, but the end-result was not stated.

(4) Crane²² reported a tumor composed of spongy lymphangiomatous tissue in a man 39 years old. The growth evidently was a true lymphangioma although his description is quite brief. The mass was enucleated and the patient recovered.

(5) Hill's⁷ case is a classical lymphangioma of the mesentery. It was impossible to enucleate the tumor, and the patient died.

(6) Wade and Steigrad²³ have reported a case in a girl three years old. Their very brief description is wholly inadequate, but I believe the tumor to be a true proliferating lymphangioma. The mass was resected, with recovery of the patient.

(7) Rawls²⁴ reports the case of a boy aged 13. In this instance, the lymphatics surrounding the tumor showed a simple hypertrophy. The mass was resected, and the patient recovered.

(8) Collins and Berdez¹ have reported two cases. The first was seen in a boy four years old. The tumor was so extensive that no resection was attempted and the patient died.

(9) Their second case was that of a woman 48 years old. The involvement was so extensive that resection was impossible and the patient died.

(10 and 11) Hertzler⁸ has encountered two such cases accidentally while operating for other conditions. Both tumors were found in males, one man about 59 years old and the other 30 years of age. In a personal interview, after examination of the gross and microscopic specimens of the case reported in this paper, he stated that his two cases were of the same type.

SUMMARY

(1) A true proliferating cystic lymphangioma of the mesentery of unusual size is reported.

(2) This tumor had the exact displacement of Flynn's tumor; namely, 20 by 12 by 12 cm., the largest true lymphangioma on record.

(3) Many cases are erroneously reported in the literature as lymphangiomias which in reality are merely lymphangiectases or enterocystomas.

(4) Only 11 cases of true proliferating lymphangioma of the mesentery were found, and a careful review of the literature on the subject has been carried out to eliminate those cases which do not conform to this type of growth.

The author wishes to thank Dr. L. P. Engel for the use of this material and records, and to acknowledge especially his indebtedness to Dr. F. C. Helwig for the pathologic description of the tumor, also for his many helpful suggestions and aid in the preparation of this paper.

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CONSERVATIVE TREATMENT OF ACUTE HEMATOGENOUS
OSTEOMYELITIS *

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THERE are many surgeons who advocate an immediate operation, usually bone decompression, for acute hematogenous osteomyelitis, and by "immediate" I mean an operation within hours of the time that the diagnosis is made. To this group there are few contra-indications to the method; to them the operation is more urgent and exposure of the medulla more necessary *pas et pas* with the severity of the symptoms. Seldom does one hear or read any criticism of the method, an absolution that is inexplicable in the face of the 20 per cent mortality (Table I). The loss of every fifth patient should cause one to question whether the treatment is too radical. Does this immediate decompression disregard the patient? I believe it does, and to such an extent that the patient becomes a battleground in the war between the surgeon and the infection. I hope to prove that when the surgeon is conservative, when he confines his activity to the supply of ammunition, the patient's defenses more often will confine the attack.

TABLE I *

	Number	Deaths	Mortality Bone %	Mortality Series %
Femur.....	37	8	22—	30
Ulna.....	3	1	33	4—
Radius.....	3	2	60	8—
Pelvis.....	4	0	0	0
Os calcis.....	7	1	14+	4—
Fibula.....	8	0	0	0
Humerus	9	3	33	11
Tibia..	50	11	22	43—
	121	26	21.49	100

* Does not include four cases not operated upon which died.

The principal argument advanced against conservative treatment is the theory of the pathology of the disease. It is alleged that all these infections arise in the metaphyses, from which points, because of compression by the rigid bony cortex, there is a spread throughout the medulla. Emphasis is placed on the dissemination because it destroys bone and also as the pus tension increases with the spread, sepsis will be multiplied. If this theory of genesis and contamination be true, conservative treatment, at first glance, would seem to be hopeless; action, imperative action such as immediate de-

* Read before the Philadelphia Academy of Surgery, April 1, 1935.

compression, might appear to be mandatory. The choice between the two methods, the radical and the conservative, will depend to some extent on the validity of that theory. After all, what proof is there that this explanation of the pathology has the dignity of a theory?

If the experimental evidence of the constant metaphyseal origin of this infection is to receive any credence, it must be supported by clinical observations. In a search for such corroboration, I have studied the histories of all the cases of acute hematogenous osteomyelitis treated in the Episcopal Hospital from January, 1911, to June, 1934, 121 cases in all. The location of the pus was recorded in 117 of this group, and of that number, in only 12 (Table II) was there a record of a solitary intra-osseous collection—not very strong evidence of the constancy of an initial attack within the bone. It is true that there were 24 other cases with pus in the medulla but in all of these cases there was also pus in the subperiosteal space. It is possible, as will be noted later, that the record about the pus within the bone might have been due to the desire to find it there; however, add these 24 to the 12, believe if you wish that there were 36 initial intra-osseous infections, and still you will lack evidence to support the argument for radical treatment in *all* of these infections.

TABLE II

LOCATION OF PUS (117 CASES)

Pus in bone only.....	12
Pus in bone and beneath periosteum.....	24
Pus beneath periosteum only (incision—no decompression).....	42
Pus beneath periosteum only (confirmed by decompression).....	39

The theory of the metaphyseal or intra-osseous genesis of the infection becomes more uncertain as the analysis of the 117 cases progresses. Thirty-six of the cases were discussed in the previous paragraph, so that 81 remain in the study. In all of these 81, pus was found in the subperiosteal space. In 42 of the 81, for one reason or another, the bone was not opened. In the other 39, the medulla was exposed and no pus found. To repeat, there were 39 cases of acute hematogenous osteomyelitis in which pus was found beneath the periosteum but no pus inside the bone, evidence that many of these infections started outside the cortex. I will concede that there may have been errors in observation and recording but they might have occurred in any of the three groups, the intramedullary, the combined intramedullary and subperiosteal collection or the isolated subperiosteal. The observations were made by eight surgeons, to seven of whom the intramedullary origin of the infection was almost a religion, and it seems as probable that they recorded pus when gray marrow or fat was seen, as it is probable that they missed pus when it was present. Discredit the observations of clean medulla any way you wish and still you will be faced with the fact that in the 81 cases just discussed plus 24 mentioned in the previous paragraph, a sum of 105 cases out of the 117 studied, *there was pus beneath the*

periosteum, and if this be not an argument against intra-osseous origin of the infection, then it does become evidence that the pus finds an exit, that decompression occurs, and that spread of the infection can be limited without surgical intervention.

While making this study, I gathered the impression that if I could find records of cases operated on in the early stage of the disease, the operative findings in these cases would be more indicative as to the original focus in or around the bone. I found such cases, four of them, operated on within 48 hours of the onset of symptoms, and in all four there was no pus in the medulla though there was pus in the subperiosteal space. If any explanation other than the subperiosteal origin be accepted, then one is face to face again with control of spread by spontaneous decompression, and an early one too.

The statistical study is not the only source of doubt against the metaphyseal origin in *all* cases. There is also the relationship of trauma to the disease. By trauma is meant a blow or fall or kick which is sometimes mentioned as a direct antecedent to the onset of symptoms and such trauma has been accepted as an etiologic factor. How does it act? Probably by injury to the periosteum for the reason that an injury to the medulla would occur as the complication of a fracture of the cortex, and few of these blows are of sufficient violence to do that; in fact, seldom does one see any external signs of the blow or kick, not even an hematoma. It is as easy to explain the connection between the trauma and the infection by assuming damage to the periosteum as it is to assume any other locus minoris resistentiae. A blow to the periosteum would destroy tissue and release histamine, which in turn acting as a dilator of the vessels would retard circulation and allow bacteria to be dropped out to feed on the weakened area. The fact that end arteries are prominent in the metaphysis does not limit localization of infection to that area; end arteries can be manufactured by a rupture of the vessels of the periosteum, and even though these are only end arteries for a short period, deposition of bacteria could occur in that period. Of course, this is all argument, it does not prove where the infection starts after trauma, but the evidence for the subperiosteal origin is at least as strong as the evidence for the intramedullary genesis.

The origin of the disease is of importance in the determination of spread of infection. In those cases where the pus is formed outside the bone, there will not be any rapid spread within the medulla; this is obvious. Though not so obvious, I believe it is equally true that there need not be a wild-fire contamination of the medulla in every case where the pus is within the bone and confined by it. It seems to me that spontaneous decompression of the bone is an actual occurrence and that it can thereby limit spread of infection or neoplasm. In malignancies metastatic and primary, this occurrence seems to be the explanation when the growth perforates the cortex before the entire bone is involved. If there really was an intramedullary origin in the 24 cases of Group 2 in Table II, those cases where there was

pus inside and out, then the subperiosteal pus was an accumulation from the medulla probably through a hole in the cortex. Even if there be no such safety valve as spontaneous decompression, immediate surgical decompression is unnecessary in all the cases when at the most only about one-half, and probably only one-sixth, of the records showed pus confined by bone.

And so this study, statistical and deductive, offers evidence that many infections in acute hematogenous osteomyelitis do arise outside the medulla—thus, the basis for the radical treatment in every case of this disease is not a sound theory, contrariwise, it is not more than an hypothesis.

The proponent of the conservative treatment must do more than discredit the basis on which the radical treatment rests. He must show that the latter method is actually harmful. That it could be dangerous where there is localized subperiosteal pus needs no argument since exposure of the medulla, a measure in that method, would carry infection from the contaminated area into clean tissue. Just what effect this contamination has on the mortality figures would be difficult to determine, but from the study of the 39 cases (Table II) where exposure of the clean medulla was done through subperiosteal pus, there was a mortality of 40 per cent after drilling and 35 per cent after guttering. Contrast these figures with the 5 per cent mortality in the 42 cases where the operation was limited to incision, where the medulla was not exposed after finding the pus; the difference in the percentages is so great that there can be no denial of the fact that exposure of the medulla in every case is a hazardous procedure. Not all of the deaths in the 39 cases can be attributed to the bone decompression per se; some of these deaths were due to the stage of the disease in which the operation was done—in other words, some deaths resulted from the principle of operating “as soon as possible.”

The “as soon as possible” operation may be either early or late in the disease, depending upon the time of the diagnosis, but as related to admission to the hospital, it is immediate. Thus, there may be an immediate late, delayed diagnosis and a hurried operation, or an immediate early operation which, under the radical treatment, is considered the ideal plan.

Recourse to the 121 cases already mentioned will show that neither the immediate operation nor the early operation accomplished all that it was supposed to do, that neither operation nor even the combined immediate early has been ideal. Here are some of the facts gathered from the study of these cases, *viz.*:

(1) The immediate operation mortality rate was 26 per cent as compared to the 15 per cent mortality for the delayed operation (Table III). (The term delayed operation signifies an operation any time after the first day in the hospital.)

(2) The early operation when performed within four days of the onset of symptoms was accompanied with a mortality of 39 per cent (Table IV).

(3) The operation done in the first week of symptoms (still early operation) failed to save 35 per cent of that group (Table IV).

TABLE III *

TYPE OF OPERATION AND MORTALITY

	Cases	Deaths	Percentage
Immediate évidement †.....	32	10	31
Immediate drilling †.....	18	6	33
Immediate incision.....	18	2	11
Delayed évidement ‡.....	15	4	26
Delayed drilling.....	14	4	28
Delayed incision.....	24	0	0

26%
15%

* Represents the work of eight surgeons.

† Immediate—within 24 hours of admission.

‡ Delayed—after 24 hours of admission.

(4) In the second week of the disease the operative mortality was 3 per cent (Table IV).

(5) After the second week of the disease the mortality rises to 15 per cent (Table IV).

TABLE IV

TIME OF OPERATION AND MORTALITY

Operation from Onset	Number	Deaths	Percentage for the Day
Within 4 days.....	18	7	39
5th-7th inclusive.....	35	12	34
8th-10th inclusive.....	12	1	8
11th-14th inclusive.....	18	0	0
15th-21st inclusive.....	10	2	20
22nd-30th inclusive.....	10	2	20
Over 30 days.....	18	2	11
	121	26	21.49

These facts show the mortality in the early operation is twice as high as the late one. Thus, the accurate diagnosis was a curse to the patients. The late cases had a mortality that was too high and from the study it seems that this mortality rate might have been improved by an operation in the second week of the disease, that period in which there was a 3 per cent mortality. The failure of the so called ideal plan, early and immediate operation, was due to neglect of and disrespect for the patient's defenses.

Consider the patient for a moment. Usually it is a child that is stricken. For a few days, or many, this child has suffered excruciating pain, has lost sleep, and has had fever, sometimes excessive. The patient's margin of reserve has been strained by suffering, insomnia and dehydration. Then there enters into the picture the element of fright, fright of transfer to a hospital. It is useless to depend for restoration on one dose of morphine given preoperatively and the supplemental hypodermoclysis, nor can there be any soothing by the hurried preparation for the operation. As frightened and as sick as it is, this child, if it is to receive the benefits of the immediate operation, must still face the unpleasant experience of anesthesia, must still

face the loss of more fluid at the operating table and from the wound, and must still face the danger of the contamination of clean tissues. In short, the uncorrected shock of infection is augmented by the shock of operation. It seems to me that the immediate operation in acute hematogenous osteomyelitis must weaken the depots which supply the local defenses against the invader.

Now, let us turn to the infection and its relation to the time of operation. The early operation, immediate or delayed, probably acts as an adjunct to the infection. In this stage, the spreading one, nature is attempting to wall off the bacteria and is making an effort to localize the attack. At this time, even an incision will open lymphatics in clean areas and through them toxins have easy access to the general circulation. The early operation does more than that; it affords additional food for the organisms in the form of surgically devitalized tissues. It is not only in acute hematogenous osteomyelitis that there is danger in early operation; there is the same danger in any spreading infection, and it has been particularly emphasized in infections of the face and hand.

In addition to the hazard of disseminating the infection by the early operation, there is the possibility that in a child suffering from bone pains and fever, hasty operation may cause embarrassment. Years ago Murphy made the statement that unless all cases of osteomyelitis were operated upon within 24 hours of onset of symptoms, bone necrosis was sure to follow. Such a drastic procedure in every case of bone pains will cause some cases of osteomyelitis, and has caused it. In the 121 cases studied here, no pus was found in the medulla or beneath the periosteum in three cases; these children did not have osteomyelitis before operation. In a fourth case, not included in the study, the final diagnosis was sarcoma. Not all cases of bone pains are due to osteomyelitis and it would be better to find pus at a late operation rather than no pus in an early operation.

I realize the facts that I have adduced in the previous paragraphs about the higher mortality in the early and in the immediate operation have not eliminated the possibility that these deaths occurred in the very ill patients, in those in whom the mortality would be higher. Let us take the tempera-

TABLE Va
TEMPERATURE, OPERATION AND MORTALITY
Operation Within Seven Days of Onset

	I.E.	Death	D.E.	Death	I.D.	Death	D.D.	Death	I.I.	Death	D.I.	Death
Over 105	5	5	0	0	1	1	0	0	1	0	0	0
103-105	7	4	3	3	5	1	2	2	0	0	2	0
102-103	1	0	0	0	4	2	0	0	2	0	1	0
	—	—	—	—	—	—	—	—	—	—	—	—
	13	9	3	3	10	4	2	2	3	0	3	0

34 cases with 18 deaths—53%

I—Incision or Immediate. E—Evidement. D—Delayed or Drilling.

ture range as an index of severity (there were too few leukocyte counts to use as an index) and analyze the mortality as affected by the early operation in the temperature ranges between 102° and 106° F., in those patients who were the sickest.

(1) There were 34 patients (Table Va) with a temperature above 102° F. who were operated upon within seven days of onset; 18, or 53 per cent, died after operation. In the same temperature range, but operated on after seven days of the disease, there were 24 cases and six deaths (Table Vb), an operative mortality of 25 per cent. In summation, the mortality was twice as high in the early operation on the sick patient as it was in the delayed operation for the same class.

TABLE Vb
TEMPERATURE, OPERATION AND MORTALITY
Operation after Seven Days of Onset

	I.E.	Death	D.E.	Death	I.D.	Death	D.D.	Death	I.I.	Death	D.I.	Death
Over 105	0	0	0	0	0	0	0	0	0	0	0	0
103-105	6	1	2	1	1	1	0	0	1	0	1	0
102-103	4	0	2	0	3	1	2	2	0	0	2	0
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	10	1	4	1	4	2	2	2	1	0	3	0

(2) Between 103° and 105° F., there were 26 operations and 16 deaths, 61 per cent, for the early operation, and for the operation after the first week in the same temperature range, there were 11 cases with three deaths, 27 per cent mortality. Thus, the early operation in the very sick cases had more than twice as high a mortality rate as the late operation.

(3) There were no cases with a temperature over 105° F. operated upon after seven days of onset but there were seven early operations and six patients died, 86 per cent. The mortality rate could hardly have been worse than this 86 per cent if the operations had been delayed a week.

Most assuredly the sicker cases were the ones that died in the early operation, but they died not only because of the severity of the illness, but also due to the fact that they were operated on when they were so ill.

Thus we come to the first regulation of the conservative treatment in acute hematogenous osteomyelitis and that is, delay the operation until the patient's resources have been repaired by rest, transfusions, infusion and acclimatization to the hospital; give the patient the ammunition he cannot supply. The second desideratum of the treatment is, do not operate until the local battle has been confined, and in this study the optimum time would seem to be in the second week of the disease. The third measure is, limit the operative procedure to incision only—*do not decompress* at the first operation.

Here are the statistics of this study which argue for incision as against bone decompression, *vis.*:

(1) For 47 cases of *évidement* or guttering, the mortality was 29 per cent (Table III).

(2) For 32 cases of drilling, the mortality was 31 per cent (Table III).

(3) In 42 incisions, the mortality was 5 per cent (Table III), one-fifth of guttering and one-sixth of drilling.

(4) Guttering and drilling were accompanied by 100 per cent mortality if the temperature was over 105° F. (Table VI).

TABLE VI

Temperature	Number of Cases	Deaths	Percentage
106° F.	3	3	100
105°-106° F.	4	3	75
104°-105° F.	14	5	35
103°-104° F.	16	8	50
102°-103° F.	21	5	23
Under 102° F.	63	2	3+

(5) *The only case that recovered with a temperature over 105° F. was after incision.*

(6) Bone decompression in the first seven days when the temperature was over 102° F. had a mortality of 64 per cent.

(7) There were six incisions in the first seven days in patients with a temperature over 102° F. and *no deaths*.

(8) Over 102° F. and after seven days, the mortality rate was 30 per cent for decompression.

(9) In the same temperature range and period, there were four incisions and *no deaths*.

The gist of this analysis shows that decompression is a decimating procedure in the early phase of acute hematogenous osteomyelitis and incision is a safer measure at any time, preferably not immediate.

There are a few cases where the pus will be located in the medulla only and for these incisions alone will not suffice. In these, after the incision has been made, pack the soft part for 48 hours and then open the bone.

I feel sure that conservative treatment will permit the patient to wage his own fight in a more efficient manner. I believe that a study of the cases treated by the radical method confirms that.

THE ORR TREATMENT OF PYOGENIC OSTEOMYELITIS

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THE adequate treatment of pyogenic osteomyelitis must continue to hold the interest of the medical profession. It is significant that perhaps the major portion of the literature on this subject reflects the general surgical viewpoint rather than the broader orthopedic concepts upon which Orr has based his system of treatment. The residual disabling deformities resulting from osteomyelitis are so common that our therapeutic responsibility does not end with the initial surgical intervention. The postoperative care is of the greatest importance in terminating the disease to the patient's best interests. Experience with pelvic localizations of this disease, as well as with suppurative joint lesions and associated conditions, fortifies one's confidence in the Orr principles of treatment. The radical measures, so essential in the attack upon pelvic foci, would not be feasible otherwise.

It is essential to emphasize that both of Orr's major premises—adequate drainage and adequate rest—are equally important; and that neither one alone is sufficient or can be subordinated to the other. This needs special emphasis because the method is so appealingly universal that there is, to my mind, some tendency toward technical neglect. Experience and the most careful attention to details are of primary importance in the successful treatment of pyogenic osteomyelitis. This requirement must be realized before one undertakes the problem, as its fulfilment may well tax the ingenuity and patience of the surgeon to the utmost.

It is not surprising that diametrically opposed principles are advocated in the treatment of pyogenic osteomyelitis and allied suppurative processes. The variable methods of treatment indicate the interest of the profession but nevertheless cause confusion. From experiences during the Great War, there were evolved paradoxically enough three principal methods of treatment; the chemical antiseptic of Carrel-Dakin, viable antiseptic maggot therapy of Baer, and the Orr method. This divergence of opinion, more apparent than real, was no doubt conditioned by the exigencies of war conditions. Possibly because, "in the craft of surgery the master word is simplicity," and for one reason or another, antiseptic methods are steadily losing ground in the treatment of infected wounds.

An important fundamental lesson learned from experience with the Orr method is that *pyogenic osteomyelitis—regardless of its localization—is not a surgical condition per se until the diagnosis is made; when some degree of suppuration has developed.* The student of osteomyelitis is gradually impressed by the fact that the many variable and unusual manifestations of the

disease are of relative importance only, and that there is a harmony when viewed from the proper perspective. Orr's dictum of operation, just as soon as the diagnosis is made, simplifies the problem because no distinction is made between acute, chronic, or other unusual phases of the disease.

General Discussion of Treatment and Approach to the Radical Methods of Attack.—This series is convincing proof that the ideal to be attained in the treatment of this disease is a complete eradication of the infectious bony focus whenever possible. Such factors as stage of the disease, number of lesions, complications, extent of the lesion, the patient's operative risk and above all the presence or absence of suppuration may require consideration. It may be axiomatically stated that operative intervention depends primarily upon the presence of suppuration. Let us remember that not infrequently the lesion is nonsuppurative, and occasionally spontaneous healing may and does take place, especially when the focus is metastatic. The main argument centers, however, upon the fact that pyogenic osteomyelitis is essentially a most devastating disease, which must be combatted by bold, aggressive, radical, operative measures.

The fact that acute hematogenous osteomyelitis, in any situation, is essentially and primarily a septicemia, cannot be overemphasized. The local skeletal manifestations of the disease are not surgically significant until a diagnosis can be made with a reasonable degree of certainty; when suppuration, or its definite tendency, can be clinically determined. The early discriminating diagnosis is dependent chiefly upon the observer's experience with the disease, and his degree of osteomyelitis consciousness. It is a fact that the vast majority of cases as seen in private and clinic practice are not recognized before rather obvious local signs are manifest, even in the ordinary long bone situations. Still more unfortunate is the victim of an unusual localization of the disease. Therefore treatment at the onset must be directed against the general systemic infectious invasion, being ever on the watch for localizing skeletal signs and symptoms.

There is more or less general agreement for radical excision of the involved parts in chronic and even in some subacute forms of the disease. However, acute osteomyelitis is presumably not adaptable to such measures. The reasons given are usually increased mortality and morbidity, and the difficulty in determining the limits of the lesion surgically. There is no proof that direct drainage of the bone in the acute stages increases the death rate. In most situations the changes in the bone subsequent to thrombo-embolic ischemia are evident very early in the disease after adequate operative exposure. At any rate, the division into acute and chronic stages is of more academic than practical surgical significance because the problem is quite evident when the diagnosis is made. Patients who die in the very early stages of the disease are overcome by the overwhelming sepsis. Until we know more about the relationship between the port of bacterial entry, the septicemia and the local skeletal manifestation, it would seem that adequate drainage should be instituted as soon as the diagnosis is made. The bony lesion should

be attacked whenever this can be located. This is particularly true in some situations because our pathologic studies indicate that extensive collateral changes take place secondarily throughout an entire bony segment from even well circumscribed initial destructive foci. A study of such unusual localizations as the pelvis points out and emphasizes several factors in the management of the disease as practiced inadequately by the rank and file of physicians.

Timidity, indifference, or ignorance are reflected in the treatment many of these patients received before their admission to the hospital (pelvic). Of the 29 sacro-iliac lesions, three drained spontaneously, the abscess was incised in seven instances and aspirated in two. The bone was not attacked in any of them and the rest received no treatment at all. Of the 21 ischial foci, three drained spontaneously, five received incision and drainage and the bone was curetted in one. Of the 29 iliac lesions, bony curettage was performed in four, simple incision in four and nine drained spontaneously. Of the four sacral foci only one had a soft tissue drainage. The coccygeal focus went undiagnosed until after admission to the hospital, when adequate treatment resulted in cure. Almost the same might be said of an equal number of cases involving more usual long bone localizations of the disease, particularly the femur.

I am convinced that the vast majority of cases are pitifully undertreated, As one becomes familiar with the disease he is more and more ready to adopt the most radical measures to attain a cure. The affected portion of bone should be removed no matter in what stage of the disease it is encountered at operation. No distinction should be made between acute and chronic stages of the disease in this situation in properly selected cases. The general condition of the patient and operability of the lesion should be our guide in the surgical procedure. In the subacute and chronic stages the need for radical removal of affected bone must be accepted. Now the lesion is obvious, and the operative indication is more definitely planned.

The following remarks are based upon 323 cases of pyogenic osteomyelitis treated by the Orr method up to September, 1934, in Doctor Steindler's Clinic and also on several private cases of the author's. The technic as discussed pertains to all localizations of the disease. Spinal and pelvic localizations, however, have been briefly considered elsewhere and will be taken up in detail at some later date. Aside from anatomic technical differences, the principles of treatment remain the same in all foci of the disease. The following analysis (Table I) illustrates the essential data in this series of cases, which does not include a number of instances of suppurative joint lesions, associated suppurative conditions and pyogenic osteomyelitis due to the more unusual bacterial organisms, which were treated by the Orr method. The vast majority of cases will fall into the subacute or chronic phase of the disease.

SURGICAL TECHNIC.—(*Long bones*) (*1*) *Approach.*—The most direct incisions are utilized. Incisions should be planned accurately, even in acute

TABLE I

GENERAL ANALYSIS OF CASES TREATED BY THE ORR METHOD

Site of lesion	Total number 323	Still under treat- ment		Prac- tically healed 27	Result unknown 34	Ampu- tation 6	Deaths 8
		Healed 210 (65%)	40 (12.38%)				
Femur.....	92	43	17	14	13	2	3
Tibia.....	80	53	14	8	3	2	0
Foot.....	26	21	1	1	3	2	0
Hip.....	24	13	2	2	6	0	1
Os calcis.....	15	12	1	0	2	0	0
Spine.....	13	10	0	0	1	0	2
Humerus.....	12	9	0	0	3	0	0
Knee.....	10	10	0	0	0	0	0
Sacro-iliac.....	10	8	0	0	0	0	2
Ilium.....	4	3	1	0	0	0	0
Ischium.....	5	4	1	0	0	0	0
Tibia and fibula...	6	6	0	0	0	0	0
Fibula.....	5	1	2	1	1	0	0
Radius.....	7	5	1	1	0	0	0
Ulna.....	4	4	0	0	0	0	0
Hand.....	4	4	0	0	0	0	0
Scapula.....	1	0	0	0	1	0	0
Patella.....	2	2	0	0	0	0	0
Elbow.....	1	1	0	0	0	0	0
Cavicle.....	2	1	0	0	1	0	0

cases, if care is taken to determine the site of greatest tenderness, edema, infiltration or swelling. The metaphyses are the chief sites of predilection of the disease. Roentgenologic examinations from various angles may often disclose abnormalities in density and bony architecture, even in very early cases. It is essential, however, to avoid if possible proximity to important vascular structures. Dissection is rapidly carried down to the depths either between muscle planes or by sharp dissection through the muscles and fascia. All the soft subcutaneous tissues must be incised equally in length to the skin. Funnel-shaped overlying soft tissue operative sinuses promote a too rapid extrusion of the pack in deep situations. A generous incision will allow healing to proceed from the bottom, without permitting premature closure of the soft parts. Incisions made the entire length of the limb are sometimes indicated. This is determined by the underlying extent of the pathology, and by the general condition of the patient. The resultant scars do not necessarily interfere with function later. If old sinuses and scarred areas are present it is wise to excise them in order to establish a subsequent healthy basis for the growth of granulations. An approach to the diseased area through a thick layer of soft tissue also insures abundant granulations. Drainage will be facilitated by placing incisions in the dependent parts whenever feasible. *Counter incisions should always be employed in infected compound fractures, in which situations the jagged bone ends have perforated muscle and fascial compartments.* All

fascial compartment invasions must be evacuated. The periosteum is now generously incised but stripped only enough to afford adequate access to the diseased bone. The periosteum should be preserved as far as possible. Evacuation of a subperiosteal abscess alone is rarely sufficient. The marrow cavity must be explored.

(2) *Saucerize and Remove All Diseased Bone.*—The question of how much bone to remove has always been a debatable one. The difficulty is more apparent than real. The disease is a thrombo-embolic phenomenon and one finds that the involved cortex is bloodless, pale and lusterless even when exposed very early. It should be remembered in this connection that some of the extensive bony changes noted in the roentgenogram may be merely collateral and of relative importance only. On the other hand, it is not uncommon to find more extensive involvement at operation than is delineated roentgenographically. The metaphyseal region should always be thoroughly explored when in doubt. Preliminary drilling of the cortex helps to locate actual pus formation. Following exposure of the area as indicated clinically, an adequate sculptured window in the bone will insure proper drainage. If there is evidence of demarcation, it is important to remove a layer of the contiguous healthy bone. By shallowing or saucerizing the cavity, all overhanging ledges which might hinder drainage are obliterated. The cortex may be cleanly and rapidly removed with a motor saw if so desired.

The question of curettement is a pertinent one. In very early acute cases a conservative attitude is permissible. Marrow sequestra are small and will become extruded spontaneously at a later date as they form. In the presence of frank suppuration and necrosis the marrow cavity may be gently curetted out. Vigorous scraping is not necessary and must be avoided; in this way the remaining endosteal layer is at least partly preserved. During the later stages of the disease when considerable débris and numerous small sequestra are present it is permissible to employ a more thorough curettage. It is helpful to remember that fragments of bone that are firmly anchored may be left *in situ*. When a large tubular sequestrum is present it should be removed by sufficient unroofing to insure a thorough débridement of its bed. Sometimes it is necessary to saucerize the bone from end to end. By careful inspection it will often be noted that intervening healthy viable cortex lies in the path of the proposed excision. These may well be left attached and will shorten the time of convalescence. Care in this respect also lessens the chances of pathologic fracture. In other instances, the situation presented is the extensive destruction at both metaphyses with an intervening bridge of healthy tissue. In such cases the exposure may be made by one sweeping incision which is later sutured over the intact area. Subperiosteal resection as a primary procedure is not to be encouraged except in pelvic localizations. It is the most frequent cause of pseudo-arthritis in osteomyelitis of the long bones. The most favorable time to perform such resection is when the infection has subsided and definite evidence of involucrum formation has occurred, which is demonstrable in the roentgenogram. This procedure should

be limited to parts of the body in which there is some other bony support, and should practically never be attempted where there is only one bone in the extremity, as in the femur.

Epiphyseal involvement requires fine surgical judgment in its management. When in doubt as to the exact extent of the lesion, a conservative attitude is indicated for the time being. In the presence of definite suppuration and necrosis, a thorough débridement should be performed as elsewhere to prevent a possible extension of the process with its attendant joint complications. Great care must be observed in this situation to avoid opening the joint unnecessarily at the sites of attachment of the capsular structures. When an adjacent joint is involved both situations must be dealt with at once. Waiting for one focus to heal before attacking the other merely prolongs the disability, destroys further the integrity of the untreated structures and encourages continuous reinfection.

As a general prophylaxis against subsequent pathologic fracture, it is wise to narrow down the trougling process wherever it is consistent with a thorough removal of all the diseased bone. This applies particularly to chronic cases as extensive removal of bone is seldom indicated in the early stages of the disease, especially the femur.

(3) *Dry the Cavity Thoroughly; Use Tincture of Iodine and Alcohol.*—Antiseptics play absolutely no other part in the treatment. It is here used only in the listerian sense—to exclude possible secondary contamination at the time of operation. The entire wound is generously flooded with tincture of iodine and then with alcohol. It is most important to dry the cavity as thoroughly as possible. Gauze wrung out in hot water will control practically all hemorrhage. The antiseptic, as advised, also has some hemostatic qualities. On rare occasions where the situation has demanded very extensive removal of bone, and control of hemorrhage is not satisfactorily accomplished, the writer firmly packs the entire wound wide open with large iodoform gauze packs for 24 to 48 hours, which are then replaced by the usual vaseline pack. *Control of hemorrhage locally and conservation of blood in general is facilitated by the use of a tourniquet for all extensive operations.*

(4) *Pack Wide Open, but Not Tightly, with Vaseline Gauze.*—Adequate pressure from this non-irritating pack keeps the wound open without repressing the growth of granulations. Care must be taken to lay the vaseline gauze into the wound *lightly*. This is the simplest yet most difficult part of the technic to master. The vaseline must have a fairly high melting point. The gauze strips should measure, ordinarily at least, three inches in width of double thickness and be 12 inches long. These should be most generously impregnated with vaseline. Light packing of the wound is imperative. However, it should be smoothly and carefully placed in the deepest recesses of the wound into the very bony crater. It should just fill the operative sinus and should not be folded over its edges to impede subsequent drainage. Next, strips of vaseline gauze are carefully placed on the skin up to and not over the wound edges. The skin should be covered all around for at least 8 to 12

inches. In some cases where copious drainage is to be expected the entire segment of the limb affected may be so encased. The careful observance of this detail will absolutely prevent any tendency to excoriation of the skin. A generous combination gauze dressing now follows, again at times encasing the entire segment of the limb. Voluminous padding before the plaster case is applied makes for added comfort and increases the absorptive capacity.

The vaseline pack serves several useful purposes from the local standpoint of surgical infection because it meets all the mechanical requirements necessary to maintain ideal drainage. It obliterates dead spaces. It is a non-irritating substance and can be utilized for the maintenance of a patent operative sinus as long as is indicated. The pack and plaster case immobilization maintains the operative sinus almost rigidly immovable. This is of prime importance because the ordinary bacteria are non-motile and depend upon their lodgment along muscle planes and even in the wound upon simple mechanical factors like any foreign body.

(5) *Immobilize the Affected Part in a Plaster Case with the Limb in the Neutral Position.*—This is a most important part of the technic. Absolute physiologic rest is thus obtained. The plaster case serves first to alleviate pain, eliminates subsequent deformities, and facilitates healing. Utilization of the postoperative encasement will permit even corrective bone procedures in order to procure proper alignment when indicated. There should be no halfway measures about proper retention of the affected part. A plaster case is the best means of gaining this end. The joints above and below the lesion must be immobilized. The constitutional benefits of plaster case immobilization are strikingly evidenced by the rise in temperature that occurs during changes of dressing. Immobilization and rest do not necessarily cease with the healing of the wound. They must be continued persistently until functional stimulus has produced the proper architectural reconstruction in the bone. Therefore, braces should be worn for six months to a year after the wound has healed. In this way recurrences will be minimized because of this prophylaxis against reactivating trauma.

The only indications for postoperative inspection of the wound are pain and persistent temperature. Usually, the patient pays little or no attention to the odor. It is to prevent secondary infection that the infrequency of dressings is urged. When healing proceeds uneventfully the pack is gradually extruded spontaneously. When granulations have definitely lined the bony cavity the most important phases of healing have taken place and a rapid completion of the convalescence may be expected, especially in those situations where there is naturally an adequate overlying layer of soft tissues. It is remarkable how soon and with what facility the soft parts can heal over in spite of an active bony process. This tendency to soft part agglutination must be especially guarded against in the femur, sacro-iliac joint, ischium and spine. It is a safe rule to allow closure by removal of the last vestige of vaseline when the drainage is scant and watery, the granulations are healthy and

beefy red in color, and when there is no evidence of small or large sequestrum formation.

Dressings may be changed at variable periods. As long as the postoperative course is uneventful it is unnecessary to change dressings more often than every four to eight weeks. It is a good idea to change the first plaster case at the end of two weeks because of the copious initial drainage. For the next two or three months, depending on the extent of the operation, the intervals are longer. The examination may be made through a window in the case. The prevention of secondary infection is one of Orr's major premises. It is possible to check this by bacteriologic examination of the wound at each inspection. With the proper care and technic the same organism will be repeatedly recovered, as demonstrated in a number of cases in this series. The bacteriologic examination will also serve as an index as to the progress of the wound. Closure may be anticipated and encouraged when the exudate is free from organisms. The patient is hospitalized only as long as an irregular temperature persists. After extensive operations it is advisable to change the plaster encasement and dressings under anesthesia. The postoperative and convalescent plaster case will never be omitted by one who has noted the absolute relief of pain obtained by this means.

Modifications of this technic are occasionally indicated. When both lower extremities have been operated upon, adequate immobilization is obtained by the application of two long leg encasements fixed by a rigid cross bar. This facilitates nursing care and allows the patient to sit up when the general symptoms have subsided. In adult situations where prolonged supine position, incident to hip spica fixation, is contra-indicated for any reason, this method is most suitable. With joint involvement this method may be combined with traction applied directly to the cross bar.

Operation Through a Window in the Case Applied Before Operation.—Several situations demand that this refinement of the technic should be observed. Operations performed in this manner lessen the operative period, alleviate unnecessary handling and movement of the parts, permit extensive operation, minimize postoperative fracture and greatly reduce the incidence of shock.

The chief indications for operating through a window in an adequately applied plaster case are: poor general condition of the patient and extensive lesions requiring wide resection of bone; profound toxemia in the early stages of the disease. The case should be carefully applied and an adequate window cut out at the site that has been previously determined to be the approach of election. The edges of the window are then protected with oil silk or some other moisture proof or resistant material. The life of the case is prolonged materially by the use of thick absorbent gauze pads applied uniformly so that they may serve to soak up excessive drainage. The width of the window must be at least one third of the circumference of the limb in order to permit adequate retraction of the soft parts during operation. The

length of the window, to avoid embarrassment in limiting the extent of the incision, approximates the segment of the affected limb.

Initial double lesions often require operation at one sitting. The amount of surgery indicated depends primarily upon the general condition of the patient and only secondarily upon the extent of the local lesions. It has been the experience of some surgeons that as a rule too much should not be done in the way of radical removal of bone when more than one focus is attacked at one operation. By observing the technic of operating through a window in the plaster case two extensive débridements may be rapidly accomplished. A definite rule to follow in the light of clinical experience is that the most active and extensive lesions should receive the first and most aggressive considerations of the surgeon.

Application of Fixed Traction.—Fixed traction indicates that some form of skin or skeletal traction is necessary to obtain the desired position and length of the limb, and that the subsequent maintenance of this position is dependent upon the fixation or incorporation of the traction device in the plaster case. The chief indications for this form of immobilization are in the treatment of compound and pathologic fractures; where extensive débridement predicts possible fracture; for all situations demanding circumferential subperiosteal resection of bone; in contiguous bone and joint infections, and in joint contractures which are corrected and difficult to control. Moleskin or adhesive skin traction will suffice in many cases, but the most efficient form of traction and plaster case fixation is obtained by skeletal means, preferably a rigid steel pin. The method of traction is wholly determined by the pathologic condition present. Skin traction is adequate for all situations where no actual shortening, overlapping, or deformity of the bone exists.

Secondary Operation.—Orr's operation is a primary procedure and no further operation is required as a rule. It must be evident that secondary operation may be necessary in some instances of the disease. The majority of secondary operations follow in the wake of a small group of fulminating lesions which are attacked early, but of necessity inadequately, and consequently go on by contiguous thrombophlebitis, to destruction of the remaining portions of the shaft.

When pain and high fever persist over a period of several days the wound should be carefully examined. Most frequently these symptoms are due to improper insertion of the pack or inadequate drainage of associated fascial plane collections of pus. If manipulation of the dressings does not alleviate these symptoms it is wise to reexplore the wound and its vicinity under anesthesia, and to deal with the situation as indicated. While the relief of preoperative pain is immediate after treatment by this method, the subsidence of the fever is seldom as spectacular. It generally is restored to a normal level by lysis over a varying period of time, and is conditional upon the duration of the disease, the extent and location of the lesion, the presence or absence of a bacteremia or other foci, and the adequacy of the operation. Pelvic and other extensive inaccessibly situated lesions continue to exhibit

low grade or moderately increased irregular fever for a variable period even after the most radical operative procedures. One must be very conservative regarding the necessity, therefore, of an early secondary operation. The primary causes for reoperation in the later stages of the disease are usually sequestrum formation, persistent dead space, and irregular soft tissue sinus formation. A sequestrum that does not extrude spontaneously or one which cannot be located and extracted with forceps during the change of dressings, should be removed by operation just as soon as it is evident, the general condition of the patient permits, and when no other local or general contraindications to operation are present. The same holds true for persistent residual bony cavity formation. In both situations the walls of the cavity must be thoroughly cleaned out and given another chance to heal from the bottom. Occasionally, a small bony cavity is completely filled in by an infected fibrous scar. Radical excision is necessary.

Old persistent sinuses must be eradicated. Many sinuses continue to drain simply because they are lined by a dense layer of chronic granulation tissue. When there is no underlying deep seated bony infection and the sinus is not tortuous or too deep, simple curettage may effect a cure. Tortuous sinuses must be followed up and laid wide open. Radical excision and suture except for drainage at the most dependent portion is necessary for its complete eradication and cure. Injection with a radiopaque solution and roentgenologic examination will indicate the devious extent of the lesion and whether or not it communicates with a bony focus. The latter is more satisfactorily determined at operation. Injection of the sinus with methylene blue facilitates its exploration. When a bony focus is found as the basis for the persistent sinus it should be thoroughly cleaned out. The sinus is widely excised and carefully sutured up to the point where direct dependent drainage can be established and maintained for a reasonable period.

Bozan's recent contribution in the treatment of chronic osteomyelitis, whereby an attempt is made to revitalize osteonecrotic areas by drill holes as in aseptic areas of bony necrosis, should be given serious consideration. In extensive chronic involvements the technic might be of value as a supplementary procedure to the Orr method.

General Constitutional Considerations.—The preoperative care is the same as for any major surgical procedure. It may be necessary to transfuse the patient before and after operation. We have found that repeated small blood transfusions are more efficacious than a single large one. When an extensive operation is planned, 500 to 1,000 cc. of 10 per cent glucose in normal saline given intravenously during the operation minimizes the shock. When the acute signs and symptoms have subsided, a careful search and eradication of all foci of infection is in order. In a general way, the patient's constitutional condition is cared for as systematically and rigidly as for tuberculosis. On the other hand, it is one of the most remarkable features of the Orr method to observe with what rapidity the general condition of the patient is improved, as evidenced by a gain in weight, general happy disposition and

maintenance of a high level red blood count. The presence or absence of a bacteremia or general blood infection does not modify the indications for treatment in principle, except in so far as it affects the general operative risk. The prognosis should, however, be guarded when a bacteremia is present. The extent of the operation should be limited only to what is absolutely essential in a septic patient.

SUMMARY

An experience embracing 323 cases of pyogenic osteomyelitis treated upon the principles advocated by Orr warrants our confidence in this system of treatment as a method of choice in pyogenic osteomyelitis. The Orr method standardizes the treatment of a disease whose variable manifestations are more apparent than real. The technic is based on the principles of adequate drainage and adequate immobilization and rest. It alleviates pain and suffering and is at the same time an economic procedure as it lessens the period of hospitalization and permits the ready transportation of the patient. Loss of limb and life is minimized. Deformities are minimized or prevented. It is the only treatment that satisfies the tenets of Orthopedic Surgery.

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END-RESULTS OF EXCISION OF THE ELBOW*

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CAMDEN, N. J.

WHILE it may seem heresy to advocate excision of the elbow rather than arthroplasty in all patients in the laboring classes, still to quote Lovett and Jones in the rewritten section on Stiffness of Joints in their *Orthopaedic Surgery*: "It is an open question whether this operation—arthroplasty—has sufficient advantage over excision to warrant one in pronouncing it the operation of election."

Certainly arthroplasty cannot be performed with hope of good results in all cases of stiff elbow, as all writers agree that the causative trauma or arthritis must not have been so great as to severely distort the joint and peri-articular structures, and that there are definite indications for the operation of excision in those cases which represent end-results from the graver traumata and infections.

Tuberculosis of the elbow seems the only condition where all are in accord that excision is the operation of choice. It should not be done before growth has stopped, that is, after 18 years of age, but it is interesting to note that in 1874 John Ashhurst, Jr., in commenting at length on eight cases of excision of the elbow, reported five patients operated upon in the first decade, and he refers to 119 cases collected by Hodges of Boston in which six were ten years of age or less. Incidentally, Hodges reported 15 deaths and 15 others requiring subsequent amputation in this same series.

In 1839, Bier reported a case of successful excision of the elbow. In 1905, Murphy first advocated the fascial transplant in arthroplasty, since which MacAusland and Campbell both have developed excellent technics which are accepted as satisfactory by other operators.

During the war, the French tried and gave up excision of the elbow for gunshot wounds, whereas many English reporters, notably A. E. Moore, W. M. Shepherd, C. M. Moullin, R. H. J. Swan and C. H. Fagge in the *British Medical Journal* in 1917 and 1918, and R. A. Stoney in the *Dublin Journal of Medical Science* in 1917 and 1920, wrote extensively on its value as an immediate treatment accompanying débridement for gunshot wounds destroying the elbow joint. They claimed it gave free drainage and the earlier it was done the better the end-result, infection and sepsis being prevented or more easily combatted without the development of an enormous mass of callus. All agreed that the triceps tendon and fascia should be kept intact and continuous with the periosteum and fascia overlying the ulna, and that these structures should not be divided transversely as was seen by Stoney,

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of Ireland, in several patients operated upon by German surgeons during the war.

Arthroplasty was originally introduced as a refinement of excision in which fascia was inlaid and less bone removed, thereby hoping to render the joint more stable laterally and also to give full and free painless active motion. It would seem that in a non-weight bearing joint such as the elbow, where lateral stability is not so important, but where painless motion and function are of great value, especially in manual laborers, excision is the operation of choice regardless of the lesion. The length of the convalescent period plus the necessary physiotherapy also must be considered in evaluating a procedure, in patients who are dependent upon the use of their hands to earn a livelihood. An elbow not subjected to severe physical strain is much more likely to give a satisfactory functioning result than that of a laboring man following arthroplasty, and it seems to me that all other things being equal the patient's occupation and future physical needs should be the determining factor in deciding on the type of operation to be done rather than the anatomic beauty of the part in this class of patients.

Certainly the results in resection of the elbow are not as claimed by many, unsightly and unsatisfactory, in that the joint is flail and weak, and always requires an external appliance for function. It may be a crude surgical procedure, as stated so often in the literature, but if the patient is satisfied and can freely and vigorously use the part in his work without pain or secondary traumatic arthritis, it is not an operation to be thrown into the discard in favor of one that is technically beautiful. However, the patient has rarely more than 50 or 60 degrees of motion in light occupations only, and if not constantly cared for the joint will become the seat of pain and increasingly diminished function and even eventual re-ankylosis.

Many writers say that, unless the patient is a fit one for an arthroplasty, it is better to do an osteotomy to permit of re-ankylosis in the position of choice than to do an excision. Campbell says in speaking of arthroplasty, "Unless a durable stable joint which will stand average daily use is restored, a joint ankylosed in the most useful position is far more serviceable." I wish to take issue with him unless he means that an ankylosed joint is better than one the seat of a poor arthroplasty, because a patient with a properly excised elbow is vastly better off than with a stiff elbow, no matter what the position. However, there is no advantage in a few degrees of stable motion with pain on excessive use over an excised elbow if only moderately flail. The results even in carefully selected cases cannot be foretold in arthroplasty whereas they can be prognosticated in almost any type of case where an excision is done. Intelligence, persistence, grit and a willingness to spend time are very essential to the result in arthroplasty, whereas they are not so essential for a good postoperative result in excision.

In 13 cases of a series of 14 upon whom I have done 15 excisions of the elbow by the same technic, the results have been quite satisfactory both to the patients and to myself. The other one who has been operated upon twice

is not improved. Three operations were for tuberculosis in patients aged 39, 58 and 64 years. Nine were for posttraumatic ankylosis, all old healed compound comminuted fractures, one for an acute extensive compound comminuted fracture of the three bones from which the upper end of the ulna had been lost. The average age of these patients was 31.2 years, the youngest 18, and the oldest 44. The fourteenth patient upon whom I have operated twice, each time with recurrence of ankylosis, had a very extensive typhoid osteomyelitis of the humerus of four years' duration which had been previously cleared up, except at the elbow, and who had bony ankylosis both of the elbow and shoulder. Two of the three tuberculous patients were females and two of the nine posttraumatic ankylosis cases were females. The acute case and the typhoid osteomyelitis case were males.

The technic consists in a longitudinal incision five to six inches long, over the middle of the posterior aspect of the arm, centering over the tip of the olecranon and extending down over the ulna splitting the triceps and its fascia, extension into the forearm, and the periosteum of the humerus and ulna. The periosteum is carefully and completely elevated from the humerus with the attached flexor and extensor group of muscles attached to the condyles, and joint capsule en masse. The ulnar nerve is carefully separated from its groove together with the periosteum and other structures. The periosteum is then separated from the olecranon and ulna on either side down to the coronoid and radial head, at which stage the humerus is sawed through just above the condyles, three-fourths of an inch above the joint level. This greatly facilitates the subperiosteal dissection of the anterior aspect of the ulna and radius with the overlying joint capsule, because it permits drawing the upper ends of these bones out of the wound and thus it is not necessary to disturb the ankylosis and perhaps light up any latent infection by osteotomizing through the joint as in an arthroplasty. The forearm bones are then sawed off together at the same level just above the bicipital tuberosity of the radius and just below the coronoid process, thus removing about five-eighths of an inch of bone below the joint level of the elbow approximately one and one-half inches in all. Sharp bone edges are rongeuired off. The periosteum, capsule, muscles and fascia are sutured interruptedly in two layers, being careful to cover the denuded bones, and the skin is closed with a continuous lockstitch suture. Bone wax may or may not be used to seal over the bone ends. A rubber tissue drain is inserted to care for oozing in the dead space. An internal right angle plaster splint is applied. The drain is removed in 24 hours and the splint replaced by a sling at the end of 12 days, when the sutures are removed. Passive and active motion are begun immediately and massage instituted if the muscles are too atrophic. The sling is kept on for three months to prevent overstretching the contracting muscles, especially the biceps, but the patient is encouraged to remove the arm from the sling and use it as actively as possible.

Pain is almost a negligible factor from the time of operation, and is always gone when motion begins. As a rule, within a week there is 20° to 30°

of active flexion against gravity which increases to 90° and is strong within three months, and which continues to improve for a year. Extension against gravity, that is holding the hand extended above the head, is the last function to recover, although weak extension against resistance appears about the third month, and continues to improve toward optimum for about two years. Within a year the patients learn to hold both biceps and triceps moderately tight when the arm is hanging at the side which does away with the lateral instability at rest, which is so objectionable to some. When strongly flexed there is practically never any instability at any time.

All of the males herein reported earn their own livelihood by hard physical labor, thereby increasing their muscle tone and decreasing instability, and in spite of a year or more of elapsed time at work in all but two cases, not one complains of pain either on use or at rest.

The range of flexion in the 12 successful cases is full and powerful muscular action except in the case of nonunion of the humerus and this is up to 60° , a range of 120° even here. All but one have full extension, and he lacks only 15° but since he flexes strongly to 45° his range of motion also is 120° .

Roentgenologically, all cases have developed since operation many exostoses or apparent individual bony growths from the disturbed periosteum remaining *in situ*, but from a clinical point of view these excrescences cause no symptoms and are only questionably palpable. The postoperative roentgenograms, however, are not ideal in appearance.

There was one death in the series, perhaps precipitated by surgery, in which a female, aged 58, with severe rheumatic heart disease and mitral stenosis complicating tuberculosis of the elbow, definitely a poor operative risk, whose heart lesion was judged by the cardiologist to be aggravated by the toxemia and pain from her elbow, had an excision done. The patient died on the sixth day postoperative from acute cardiac failure.

CASE REPORTS

CASE I.—H. C., female, aged 64. Disability elbow for four years previously. Diagnosis, tuberculosis with sinus. Excision, January 20, 1927. Entirely healed by July, 1927. One year later, January, 1928, full flexion and could hold extended against gravity at 135° . Disease inactive. Although now living in another part of the state, her family reported in 1931 that she had full use of her elbow and that it caused her no trouble.

CASE II.—M. B., female, aged 58. Disability elbow for one year previously. Diagnosis, tuberculosis, complicated by rheumatic heart disease, mitral stenosis and increasing decompensation, thought by cardiologist that it was being made worse by disease of elbow. Excision, April 9, 1934. Death on sixth day due to acute cardiac dilatation.

CASE III.—B. D., male, aged 39. Disability followed injury in 1927. Diagnosis, tuberculosis with sinus formation. Excision, February 8, 1932. Wound healed by June 6, 1932, with full flexion present and extension against gravity at 150° . Not seen since although returned to full duty as a bakery laborer. Disease quiescent.

CASE IV.—W. L., male, aged 31. Compound comminuted fracture all three bones about elbow with loss one and one-half inch upper ulna, including olecranon, August 20, 1930. Excision and débridement of injured area, in presence of rather active infec-

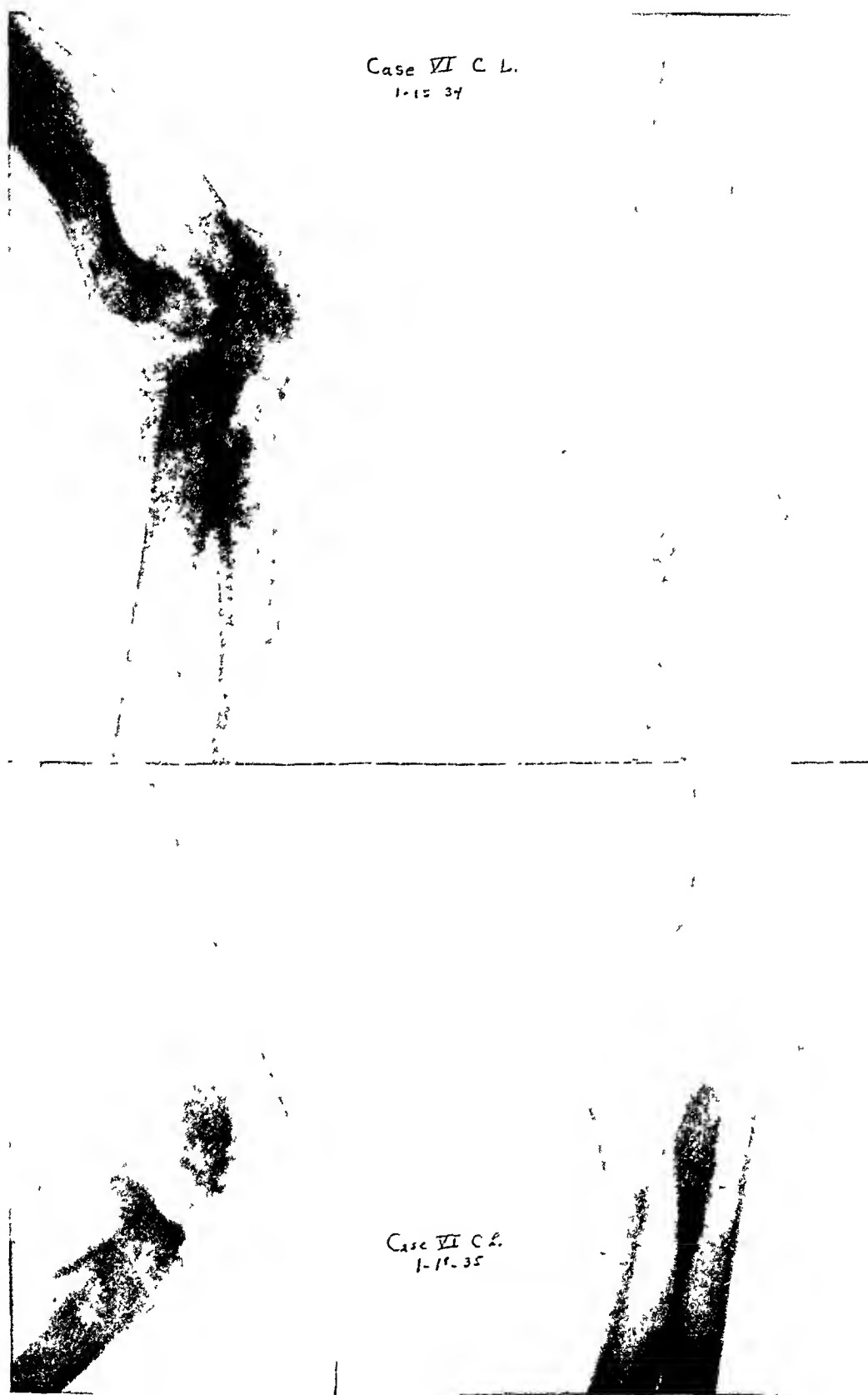


FIG. 1.—Note solid preoperative ankylosis and bony debris about the joint postoperatively.

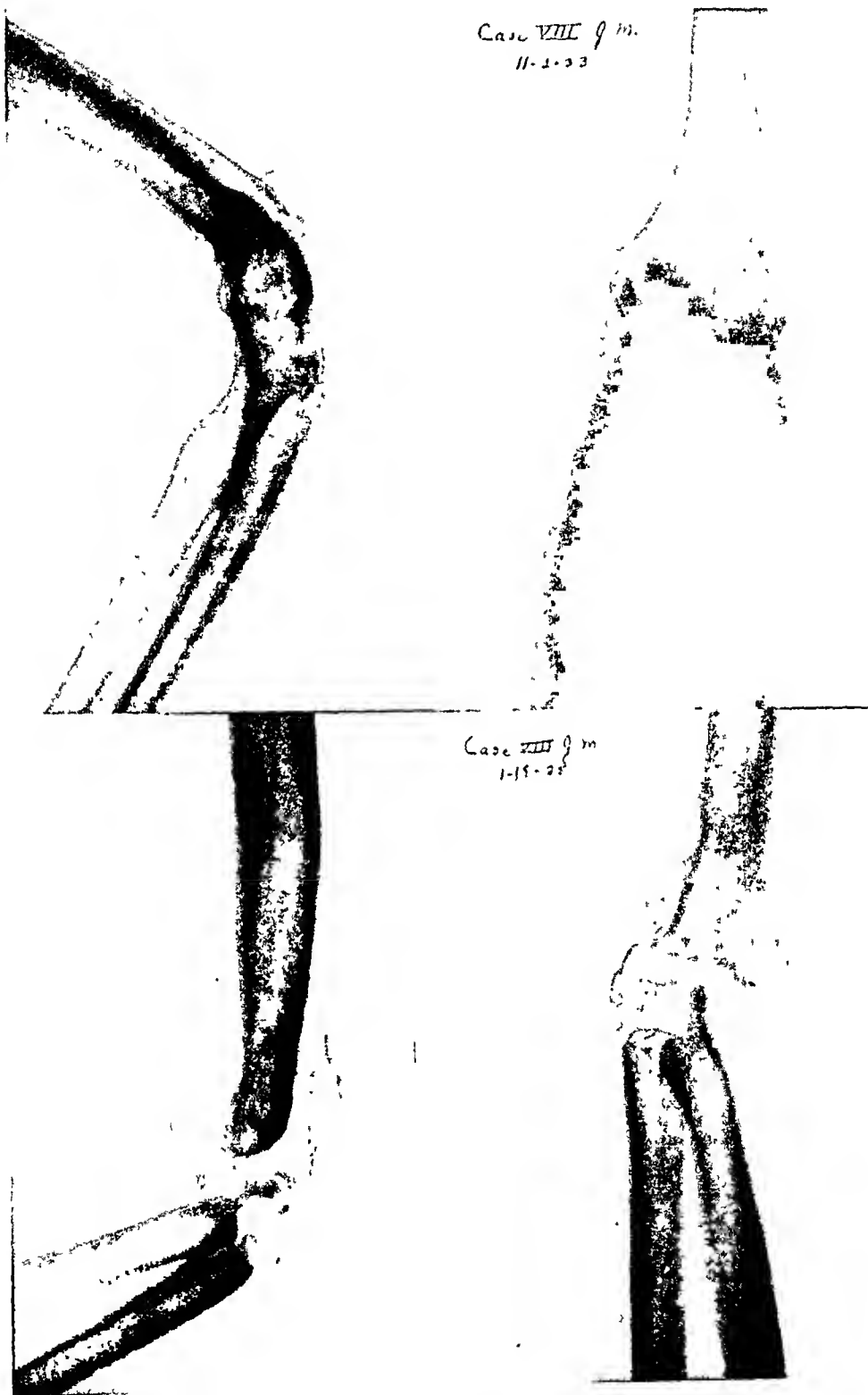


FIG. 2.—Note solid bony ankylosis preoperatively and regeneration of spur of bone from radius postoperatively.

tion, with repair of lacerated triceps August 28, 1930. Wound drained profusely for one month, then only mild seropurulent discharge until November 1, 1930, when the wound became solidly healed. Motion was urged after the severe drainage lessened. When last seen about February 1, 1931, had strong flexion to 30° beyond a right angle and almost full extension against gravity.

CASE V.—L. Y., male, aged 28. Compound comminuted fracture elbow August 20, 1931. Healed about January 1, 1932, ankylosed at 155° . Excision, February 12, 1932. Entirely healed, March 11, 1932. By March 29, 1932, he had flexion to right angle against gravity, and by April 22, 1932, full flexion was possible, and by May 17, 1932, was able to drive a truck. Physiotherapy was begun March 19, 1932, and stopped April 22, 1932. When last seen in February, 1934, had full flexion against resistance and full extension against gravity and considerable resistance.

CASE VI.—C. L., male, aged 44. Sustained severely comminuted and compound fracture of the elbow May 27, 1933. Wound entirely healed in December, 1933, ankylosed at 140° . Excision January 10, 1934. Postoperative wound healed February 14, 1934. By May 2, 1934, there was very strong flexion to 15° beyond a right angle, and by June 13, 1934, he had returned to work as a fireman and was able to hold his arm fully extended against gravity (Fig. 1).

CASE VII.—L. McG., male, aged 26. Sustained compound comminuted fracture of elbow May 4, 1929. Wound healed July 26, 1929. Elbow ankylosed at 120° . Excision, November 26, 1929. Wound was healed within a month and on May 20, 1930, had full flexion and extension against gravity and resistance.

CASE VIII.—J. M., female, aged 21. Sustained compound comminuted fracture elbow November 27, 1932. Wound healed in May, 1933. ankylosed at 90° . Excision, November 2, 1933. Wound healed November 24, 1933. By January 22 1934, had full flexion against gravity and resistance. Extension against gravity is still weak but improving. Working as an assembler of radios (Fig. 2).

CASE IX.—T. T., male, aged 18. Severe simple fracture lower humerus December 24, 1929. Ankylosis at 90° . Excision, November 2, 1932. Primary union. By January 10, 1933, his range of motion was strong from 165° to 75° and now from full flexion to 165° extension strong in both flexion and extension and working as a helper on a truck (Fig. 3).

CASE X.—E. B., female, aged 36. Sustained comminuted fracture head right radius on May 23, 1934 which was excised on May 28, 1934. Primary union. Physiotherapy begun June 20, 1934. On July 7, 1934, there was present posterior dislocation of the elbow with much extra-articular callus and ankylosis at 90° . Excision, October 8, 1934. Now strong flexion to 90° . Slight triceps action only. Improving constantly (Fig. 4).

CASE XI.—L. F., male, aged 34. Sustained compound comminuted fracture of all bones about elbow and a compound fracture of the middle of the humeral shaft, ankylosis at 90° . Still had sinus from elbow and middle humeral shaft on October 14, 1933, when excision done. Elbow healed, January 28, 1933. Sequestrectomy of humerus. September 5, 1934. Entirely healed, October 31, 1934. Full flexion although not strong. No extension against gravity as yet.

CASE XII.—A. A., male, aged 36. Sustained compound comminuted fracture about elbow and fracture middle humeral shaft in September, 1930. Ankylosis elbow at 90° and non-union humerus. Bone graft of humerus September, 1932. Graft absorbed. Excision elbow March 10, 1933. Primary healing. At present working as farmer with leather cuff for humerus. Very strong flexion to 60° . Extension against gravity to 135° . Awaiting open fixation of humeral fragments.

CASE XIII.—W. McC., male, aged 38. Extension comminuted fracture all bones at elbow with fractures of radius and ulna in forearm at lower levels September 28, 1934.

Case IX 1.1
3-16-32



FIG. 3.—Note absence of olecranon and deformity of lower humerus preoperatively and calcific deposits postoperatively.

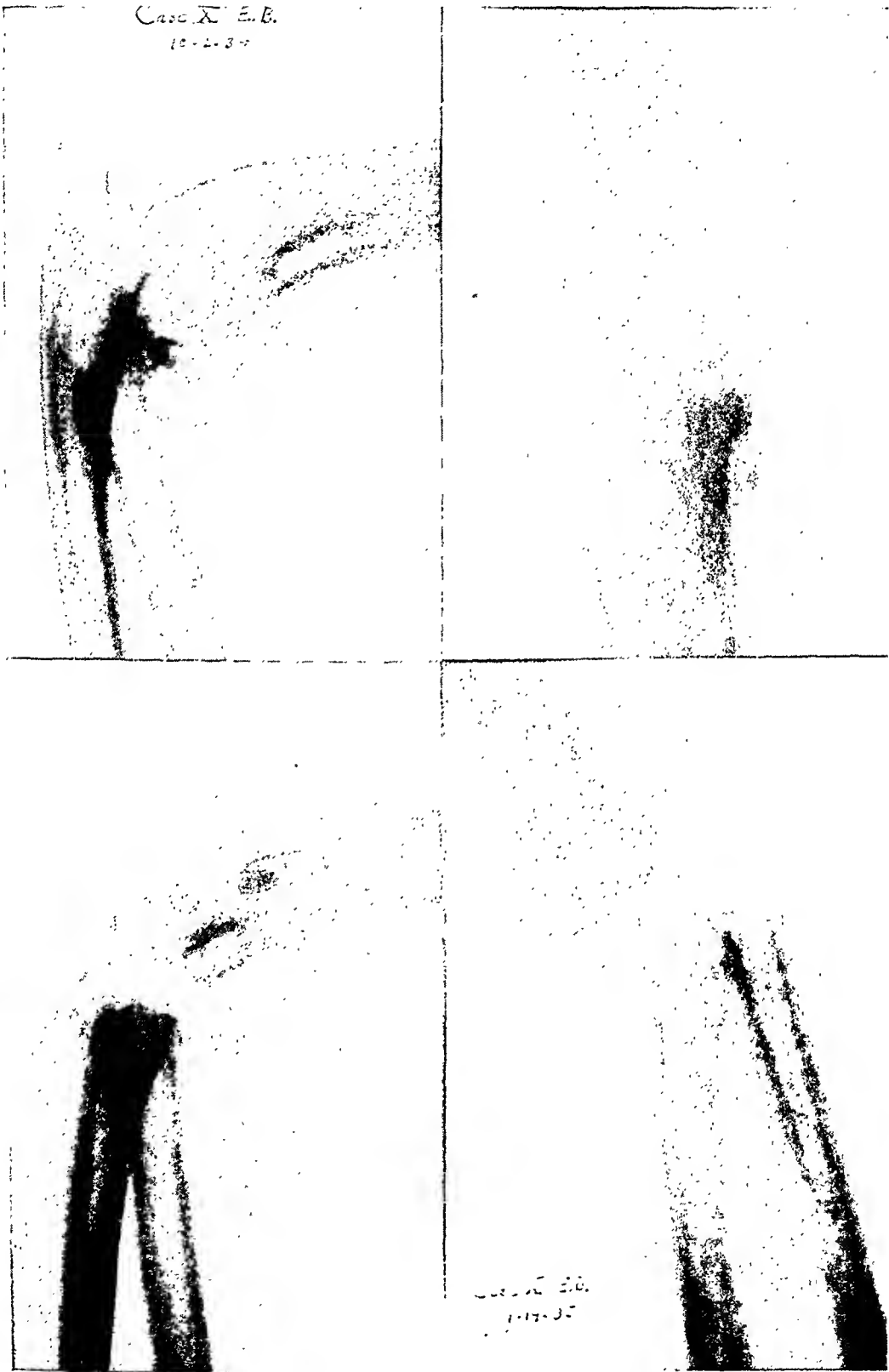


FIG. 4.—Note ankylosis with posterior dislocation of forearm bones and small amount of postoperative debris.

Forearm fractures fairly solid by January 16, 1935, and elbow ankylosis at 165° when excision done. Primary union. Still in splint.

CASE XIV.—Male, aged 19. Typhoid osteomyelitis entire humerus with ankylosis shoulder to side and elbow at 110°. Guttered and treated by Orr technic in November, 1930. Healed, all but at elbow, where sinus still existed in January, 1932. Primary excision done then. Rapid regeneration of bone and re-ankylosis. Wound healed in three months. Reexcised October 5, 1933, with primary union, but again regeneration of bones closely resembling in shape the portion of elbow removed. Ankylosed at present at 170°. Possibly a third excision may be performed.

CONCLUSIONS

While this is a small series of cases on which to base any opinions in such a controversial matter, I bring them forward as a plea for the operation of excision of the elbow in those cases where arthroplasty does not give the best outlook.

DISCUSSION.—DR. JAMES MARBLE (Boston, Mass.). Some ten years ago, Dr. James M. Hitzrot, of New York, recommended the excision of the lower end of the humerus in cases of comminuted bimalleola fractures of the lower end of the humerus. These cases seemed to give very excellent results, although there was some lateral instability at the elbow. It was following Doctor Hitzrot's demonstration that I operated upon an artist with a compound comminuted fracture of the lower end of the humerus in whom the bone was shattered into many pieces. The result was very satisfactory. The patient had a full range of motion but with considerable lateral motion. She was able to resume her former occupation and has a very useful arm.

The cases Doctor Buzby has demonstrated seem to be very satisfactory. He has excised the elbow joint, removing about one and one-half inches of bone. It is all done subperiosteally. The resulting motion is excellent. There is a moderate amount of lateral instability. The patients can initiate flexion. The muscular power is good. The grasp of the hand is excellent. They can all do hard work.

The operation, as it is described, seems relatively simple. Certainly his results are very satisfactory.

DR. HENRY P. BROWN, JR. (Philadelphia), asked if any effort was made to retain the motion of the triceps.

DOCTOR BUZBY.—In answer to Doctor Brown's question, by splitting longitudinally through the triceps fascia over the tip of the olecranon down into the forearm and the periosteum of the humerus and ulna, the insertion of the triceps is not disturbed, in that the periosteum and fascial covering on the ulna have not been disturbed. The triceps contracts sufficiently eventually so that with its fascial insertion it is possible to extend the ulna.

BRIEF COMMUNICATIONS AND CASE REPORTS

TOTAL REMOVAL OF PAROTID GLAND WITH PRESERVATION OF FACIAL NERVE*

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CASE REPORT.—Andrew K., aged 38, an auto mechanic was first seen December 24, 1934, complaining of a tumor in the region of the left ear. He had first noticed, about six months before admission (June, 1934), that his left external auditory meatus seemed to be getting smaller. There was also a dull pain, and a diminution in his hearing on that side. About one month later, he noted a lump behind the left ear—the size of a finger tip. Two months ago (October, 1934) an enlargement in front of the ear appeared which has rapidly increased in size and consistency. The nodule behind the ear was excised November, 1934. For the past two weeks the pain in front of the ear had markedly increased.

Examination was negative except for the local condition in the region of the left ear. The ear lobe sticks out somewhat and the face, in front of the lower portion of the pinna, is visibly larger on the left than on the right. This is caused by a dense stony infiltration underneath the skin extending from the tragus downward to the lower border of the ear lobe. The induration involves the superficial tissues but is not attached to the skin. It does not involve the angle of the jaw, but is above and behind it, seemingly directly subjacent to the external auditory meatus. The inferior wall of the external auditory canal is pushed up and partially closed and the skin edematous. The ear drum is slightly retracted, otherwise negative.

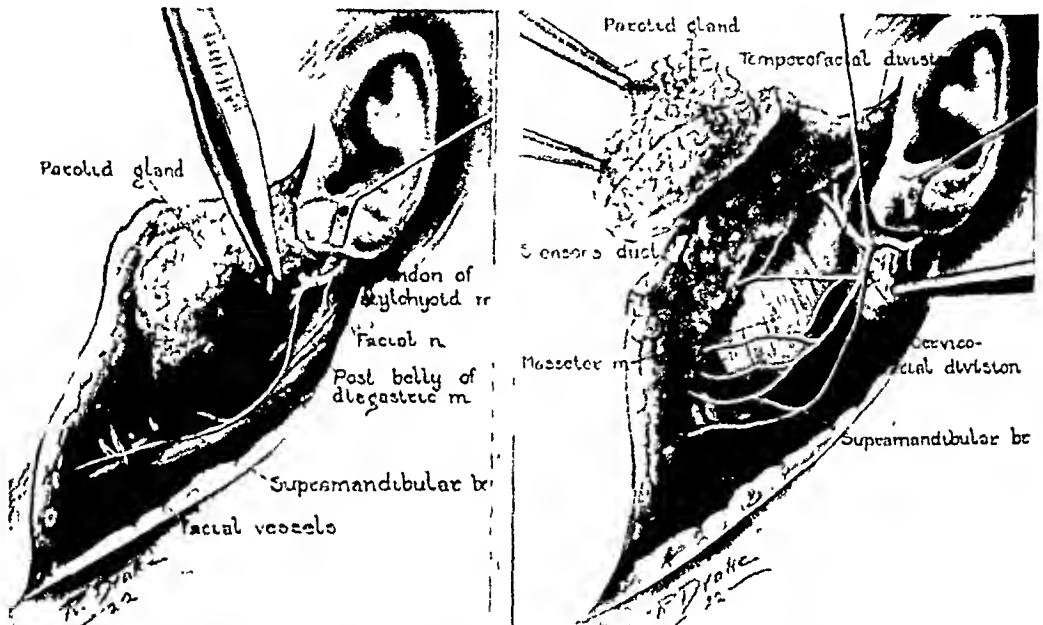
The location of this tumor precluded simple enucleation. It evidently lay deep in the fossa in front of the mastoid, immediately behind the facial nerve and underneath the external auditory canal, and because of its active growth a total removal of the parotid gland appeared justified. Sistrunk¹ and later Adson and Ott² have described the removal of the entire parotid gland with preservation of the facial nerve; McWhorter,³ Shaar,⁴ Grove,⁵ and others⁶ have described removal of these tumors by this method.

Operation.—January 8, 1934.—Under general ether anesthesia, a curved horizontal incision was made below the ramus of the mandible, extending posteriorly one inch behind the mastoid process. The inframandibular branch of the facial nerve was recognized underneath the platysma a short distance in front of the angle of the jaw and three-eighths of an inch below the bony edge. It was about twice the thickness of a heavy silk suture. This was followed carefully up into the substance of the parotid gland. About one-half inch within the gland, it began to curve down into the depth. The skin incision was then extended vertically upward in front of the ear. The gland was incised until the bifurcation of the facial nerve into its upper and lower main branches was reached. With the plexus of the facial nerve fibers thus exposed, the superficial portion of the parotid was next dissected off, using the plane of these fibers as the floor. As Adson and Ott have noted, the facial nerve travels through the gland for a distance of 2 cm. only, and if the vertical incision is made close in front of the ear, there is little danger of injuring it (Figs. 1 and 2). There is a natural embryologic division of the parotid into a superficial portion overlying the facial nerve and a posterior portion beneath it (McWhorter³). This facilitates dissection. Malcolm⁷ has also described the detailed surgical anatomy of this region.

* Read before the American Society for the Study of Neoplastic Diseases, Washington, D. C., September 6, 1935.

With this part of the dissection completed, and Stenson's duct ligated, attention was now turned to the posterior part of the gland which contained the tumor. The facial nerve was traced, curving downward behind the ramus of the mandible in a trunk the size of a pencil lead, one-half inch above the angle of the jaw. It lay well anterior to the tumor mass. The vertical incision was then curved around the cartilage of the ear, meeting the posterior extension of the original horizontal incision after excising a one and one-half inch triangle of skin behind the ear, widely including the biopsy site. The posterior portion of the parotid was thoroughly excised, hugging the cartilage of the concha, the inferior border of the auditory canal, the anterior mastoid eminence, anterior border of the sternomastoid fibers and carefully removing all vestiges of the gland from the depth behind the facial nerve to the belly of the digastric muscle.

The ear lobe came down easily to fill the skin defect behind it. There was no post-operative reaction or facial paralysis. His hearing returned completely within two weeks.



FIGS. 1 and 2.—The supramandibular branch of the facial nerve is followed up to the under surface of the parotid gland and into its substance to expose the main trunk of the nerve. Note that vertical incision in front of the ear close to the pinna avoids the upper division of the facial nerve (which supplies the eye) and that the ramifying fibers of the facial nerve lie on a plane on the surface of the masseter. The anterior portion of the parotid gland is superficial to this plane and, after this exposure, is easily dissected out. (Courtesy of Doctors Adson and Ott and the Archives of Surgery.)

Microscopic Examination.—(Dr. Charles F. Geschickter). "The section shows a mass of fibrous tissue invaded by cords of very small compressed basal cells with dense nucleus and little cytoplasm. The relative amount of stroma is large. There is no cartilage in the section examined and there also are no solid epithelial nests of cancer. While there is no sharp dividing line between benign mixed tumors of the parotid and basal cell cancer, I would be inclined to place this section with the former."

Röntgen ray therapy was begun two weeks postoperative, receiving 14 treatments, two or three days apart. On May 18, the lymphatics of the neck were removed, using Semkin's¹⁰ technic. There has been no recurrence during the past two years (Fig. 3).

Mixed tumors of the parotid are not very malignant. Many instances are recorded where the tumor remained stationary and unchanged for 30 to 40 years. Nevertheless, a certain number take on active growth later, at times growing into enormous ulcerating masses, extending, in one case we have seen, six inches from the side of the head and rapidly infiltrating the

nodes of the neck and extending into the mediastinum. Most surgeons believe that if completely enucleated they do not tend to recur, but if the capsule is entered, the spread may be rapid. There have been recurrences 20 years after local removal.

The angle of the jaw is the most frequent site of origin. However, they may start posteriorly, anteriorly, or in the upper portion of the parotid, and one should not be misled because the site of origin is not usual. Though reports from radiologists are conflicting, it seems certain that some, at least,

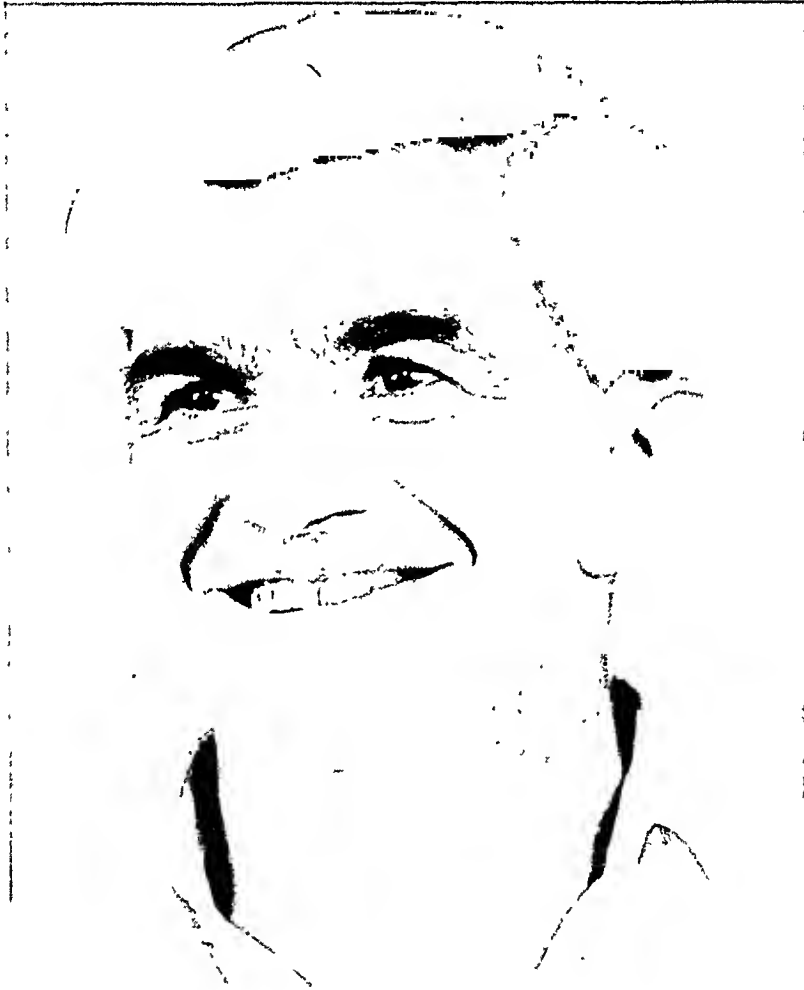


FIG. 3.—Appearance of patient two years after total removal of parotid gland.

of the mixed tissues composing these tumors are not affected by radiation, and only temporary decrease in size is produced by irradiation. No authorities so far as we know consider them radio sensitive.

Stein and Geschickter⁸ show clearly that the parotid gland in an 18 Mm. human embryo is an outpouching of the buccal epithelium and the actively proliferating tumor element is an elongated basal cell which transforms into a more cuboidal or columnar type; *i.e.*, epithelial in origin and not endothelial as some have previously held. From its earliest stages, the parotid lacks a specialized fibrous capsule: the epithelial cells diffusely invade the surrounding connective tissue, apparently stimulating this precartilaginous substance

to react and to proliferate. The result is a composite tumor of both epithelium and connective tissue—mixed tumor.

Malignant tumors are of the basal cell type: derived from the basal cell layer of the primitive buccal epithelium from which the salivary glands are derived. They recur and extend locally, but rarely metastasize.

Thus, the difference between mixed tumors and carcinomata is one of degree and clinical course rather than their being distinct pathologic entities.

SUMMARY.—A case of tumor of the parotid directly beneath the external auditory canal is described in which total removal of the parotid with preservation of the facial nerve was accomplished, and who has remained well for two years.

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TOTAL COLECTOMY FOR CHRONIC ULCERATIVE COLITIS*

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CASE REPORT.—A female, aged 16, was admitted to the Pennsylvania Hospital in April, 1927. Her past history had no bearing on her illness which began in August of 1926 with a bloody diarrhea. Within one month she was having 10 or 12 bowel movements daily. The stools contained a large amount of blood and defecation was accompanied by cramp-like pains over her entire abdomen and an intense burning in her rectum. She had an irregular fever. These symptoms continued with occasional remissions and in eight months she lost 30 pounds in weight. She was given a number of blood transfusions and various forms of treatment were tried. A guinea-pig inoculation from the stools was negative for tuberculosis, as were tuberculin tests. It was thought she might have chronic amebic dysentery with secondary bacterial infection, but finally a diagnosis of chronic ulcerative colitis was made. In April, 1927, her hemoglobin was 27 per cent; when discharged to a convalescent home in June, 1928, it was 74 per cent, the diarrhea had abated and she was able to be about the ward. This remission of symptoms lasted until August, 1927, when blood again appeared in her stools and gradually all the former symptoms returned, but with less severity.

Roentgenologic examination after a barium enema showed a gross abnormality of the transverse colon extending distally from the hepatic flexure. The entire colon distal to this was very narrow, especially in the lower portion of the sigmoid. The narrowing

* Presented before the Philadelphia Academy of Surgery, April 1, 1935.

was partly due to spasm as the lumen varied in size during the examination. There was a marked insufficiency of the ileocecal valve.

Proctoscopic examination at this time showed an inflamed mucosa with ulceration. Later proctoscopic examination was impossible even under an anesthetic because of narrowing of the lumen of the bowel. In July, 1929, an ileostomy was performed. The ileum was completely divided about 12 cm. from the ileocecal junction. This operation resulted in considerable relief, but tenesmus and the discharge of bloody mucus from the rectum continued. A rectovaginal fistula developed. Her general health improved greatly, but at no time was she completely relieved of symptoms. She was kept under observation and in January, 1932, colectomy was decided upon. This was performed in two stages. At the first operation, the terminal ileum, the cecum, ascending, transverse and descending colon were removed. The bowel was so friable that it was torn through by the traction of its own weight while the mesosigmoid was being divided. It was necessary to remove the greater part of the omentum which could not be separated from the transverse colon. The sigmoid stump was brought out through the lower part of the wound. Four months later the sigmoid, rectum and anus were removed. Two weeks after this last operation, she developed an intestinal obstruction which necessitated a laparotomy for the division of adhesions. Four months later a similar occurrence took place and again it was necessary to operate upon her and divide bands of adhesion. After this she made a good recovery and for the past year has been employed as a domestic.

The segments of bowel removed at the two operations were hard and covered with firm yellow fat. A large portion of omentum was attached to the transverse colon. The wall of the colon was thickened and so contracted that only a pencil sized lumen was present surrounded by a wall 7 Mm. thick. In the ascending colon, 5 cm. from the ileocecal valve, a point of constriction almost occluded the bowel. The terminal ileum showed some slight thickening. The appendix apparently was not involved in the inflammatory process. Microscopically, the mucosa of the colon was ulcerated in areas. The lymph tissue was quite hemorrhagic and rather loose. The muscularis was thickened with small areas of scar and fibrosis. Scattered throughout all the sections were small areas of localized accumulations of round cells and a few endothelial cells. Occasionally in these areas a multinuclear giant cell was seen, but no central necrosis. The section of ileum showed nothing abnormal. Bacterial stains failed to reveal any organisms in the tissue. A pathologic diagnosis of chronic ulcerative colitis, etiology undetermined, neuromata and fibrosis of the colon was made. Dr. John Bauer who examined the tissues made the following comments:

"The changes shown in the sections are most remarkable. The mucosa is diminished in amount, at many places ulcerated and replaced by granulation tissue. The submucosa is greatly thickened, chiefly by hyaline areas of fibrous tissue devoid of infiltrating cells (probably the scars of former lymphoid centers), a diffuse cellular infiltration chiefly of lymphocytes and a few mononuclears and polymorphonuclears and enlarged hyperplastic lymph follicles. The follicles show marked proliferation of the secondary centers, some mononuclear cell infiltration and epithelioid cells with hyaline patches. The amount of lymphoid tissue is distinctly increased, but everywhere shows inflammatory activity and not neoplastic changes. There is an irregularity in the muscularis due no doubt to the destruction by a continuation of the inflammation from the mucosa and submucosa and subsequent healing. Many collections of lymphocytes are seen. The nerves have become thickened into the form of neuromata. A section of lymph node within the mesentery shows marked hyperplasia, dilatation of the sinuses and a cellular reaction consisting of large flat mononuclears and a few eosinophiles. Here, too, the secondary centers are prominent and contain hyaline deposits. All of the changes suggest a low grade, longstanding chronic infection, in places associated with healing in others with ulceration of the mucosa and accentuated activity. The histologic studies simulate tuberculosis in places but lack the characteristic necrotic foci, epithelioid cells or giant cells. No amebae are seen."

BOOK REVIEW

TUMORS OF THE URINARY BLADDER. By EDWIN BEER, M.D. Baltimore, William Wood & Co., 1935.

This monograph is introduced by an excellent historic sketch, extending from the ancients down to the present time. Real progress, it is pointed out, began with the use of the cystoscope, and the author, in 1910, was the first to use the cauterizing spark inside the bladder for the purpose of treatment. He used the Oudin current. Paskis of Vienna in the following year suggested the use of radium. In 1912, Edwin Beer advocated extraperitonealization of the bladder for operations for cancer.

A good description of cystectomy and transplantation of the ureters into the bowel as well as the skin, which methods have been developed in the last 15 years, are also discussed thoroughly.

Doctor Beer concludes, and the reviewer agrees thoroughly, that deep roentgen ray has proved a dismal failure in the treatment of bladder carcinoma during the last 10 years.

Chapters have been devoted to the incidence of the disease with some discussion of the causation. The biologic characteristics are gone into thoroughly, as well as the pathology and classification of bladder tumors.

The symptoms and diagnosis of bladder tumors are exhaustively considered and the author properly points out that cystoscopy, with the taking of biopsy specimens, as well as cystography, are methods of precision which are most helpful to the examining surgeon.

In the discussion of treatment, all methods have been tried. A painstaking and accurate tabulation of the results obtained with each method is given. There is also a chapter devoted to combination therapy, which is very interesting indeed.

The monograph presents a subject of universal interest, handled by an expert, in a fair and meticulous manner as regards history, diagnosis and treatment by all methods and his results in 600 cases.

OSWALD S. LOWSLEY, M.D.

EDITORIAL ADDRESS

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PRESIDENTIAL ADDRESS

THE MASTER SURGEON AND THE LAYMAN

ROBERT LEE PAYNE, M.D.

NORFOLK, VA.

ROBERT BROWNING wrote: "Man's reach must exceed his grasp, else what's a Heaven for?" Thomas Carlyle stated that "Our main business is not to see what lies dimly at a distance, but to do what lies clearly at hand."

If there is an apparent inconsistency here between the thought of the poet and that of the historian, as the two apply to our problem, it is only an apparent inconsistency. Surely, we of this Association and of similar and kindred Associations are not to be content to reach only for such objects as we can certainly attain, or we are but little more than craftsmen. But surely, too, we are to do what lies clearly at hand, or we are but dreamers. If we are only dreamers, then we are not exemplars of Kelvin's proposition that the life and soul of science are in its practical application.

We are here today as practical men. Scientists, we ought to be; idealists, we hope we are; but practical men we must be, if we are to play our full part in the joint effort that brings us here together.

Because we are scientists, and because for program purposes this address had to have a title, I have captioned this address, in part, "The Master Surgeon," and because we are practical men, I have called it, in other part, "and the Layman." The two, in their actual existence, touch each other so intimately as to be well-nigh indivisible. Let us consider first, separating him for the moment, The Master Surgeon. What is he? What are his qualifications?

Passing as a matter of course, as well established these days, the requisite that he possess the breadth of education and general knowledge that is attested by an academic degree or adequate academic credits, we demand also, as a matter of course, that he be thoroughly and firmly imbued with knowledge of the principles of medicine and surgery as inculcated by approved medical schools. After he has obtained his license to practice medicine, with or without the experience of internship, he is legally qualified—legally, he is noted—to practice surgery. He is not fitted, however, to practice surgery. He is not, indeed, well fitted to practice medicine. So much the less is he fitted to practice surgery, without supervision.

Let us assume that he has become an adequately equipped medical man. And he must be that first. There is, I fear, a tendency today on the part of many young graduates to assume that they can safely leap from the medical school, over all experience of the practice of medicine, into the field of surgery. That assumption is not justified. The practical surgeon who is in truth a Master Surgeon knows that Mayo and Archibald, and all others, are eternally right when they say that the surgeon must be primarily a well trained practitioner of medicine, and he holds with Haggard, and the others who have said, that the scientist must never become so interested in the disease that he forgets the patient. Let us say, then, that the aspirant has become an adequately equipped medical man. Either he is now prepared to be trained and to train himself to be a Master Surgeon, or he has been under training to that end while he was equipping himself as a medical man after his graduation. For the teaching and the learning of surgery are as surely postgraduate work as is the earning of the academic degree of Ph.D. a matter of postgraduate work. The principles of surgery, to repeat, are taught in the medical schools. The application of these principles is learned after the medical schools have conferred their degree of M.D.

I stress the difference—and not as a grammarian—between the words “taught” and “learned,” because in the medical schools the aspiring surgeon is taught by those who are—certainly as to the student—primarily teachers. That is literally true of teachers who are full time men. It is also virtually true—as to the students—of those part time men, surgeons in active practice, who instruct classes or groups. Both classifications *teach* the principles of surgery. But the application of these principles must be *learned* by the aspirant. And it can best be learned from, rather than taught by, Master Surgeons who are not primarily teachers.

At least, that is the case in the main today. Eventually, the system under which the University of Minnesota grants first, the degree of Bachelor of Medicine, and later, after compliance with specified requirements, the degree of Doctor of Medicine, may be so extended and developed as to include a degree of Doctor of Surgery. The holder of such a degree may have been required to serve so rigid an apprenticeship, in the most favorable circumstances, in the practical application of surgical principles, as to have become a qualified surgeon. That would mean, however, that he must have under-

gone a period of three or five or even eight years of postgraduate application. Such a degree based upon such requirements is at this time, however, among those ideals for which we may reach but which we cannot as yet grasp.

There remains, then, the utilization of such resources, such facilities, such advantages, such opportunities, for the production of Master Surgeons as we have.

In a wholly inadequate manner, we attempt such utilization in the awarding of the F.A.C.S. degree by the American College of Surgeons. This degree, I think we all know, merely represents fulfilment on the part of its holder of requirements which are far too lax and which are, in a number of respects, of doubtful wisdom. Indeed, it represents something unpleasantly like a membership in a trade union. Worse, it represents membership in a trade union which does not obligate itself—as does so well conducted a labor organization as the Printer's Union, for example, to produce a sufficient supply of properly trained members. In this regard, the American College of Surgeons does those things which it ought not to do, and leaves undone those things which it ought to do. And yet, the F.A.C.S. is the only, even remote, approach to that degree of Doctor of Surgery, or Master of Surgery, toward which we are somewhat gropingly reaching.

Permit me to digress and say that this reaching for a Master's qualifications is as much, if not more, for the benefit of the layman than for individual attainment. The layman has no guide by which he may choose a qualified surgeon, and while our first duty is to provide adequate postgraduate teaching, it is equally important that we educate the layman, and provide a reliable criterion by which he may know to whom he may entrust his life or that of his family. For the time being, this latter responsibility must be put squarely upon the shoulders of the hospitals. Only qualified Master Surgeons should be given full privileges of the operating rooms in our hospitals, and this should be the very foundation upon which the American College of Surgeons is built. By this criterion only may our layman be educated to choose and select. By this means, when our layman is hurriedly urged into the hospital for surgical attention, he will quickly learn that his family practitioner, whom he idolizes, is not always competent to handle the problem which is to be faced.

In an article in the *ANNALS OF SURGERY* for October, 1935, which is the product of an exceptionally extensive survey and illuminating analysis, Doctor Archibald points out that the Royal Australasian College of Surgeons requires, among other things in the creation of its Fellows, "a minimum of five years' postgraduate training in surgery under an approved senior surgeon."

As there are many men, there are many minds, so it is easily conceivable that three or four years of postgraduate training of this character would suffice to equip some men, while others might need six or eight. Nevertheless, as fully as I realize the weaknesses and the dangers of standardization, I am not inclined to dispute the conclusion that there should be a minimum of five years of such training.

Such a requirement might work a hardship in some cases, but the compelling need of providing the greatest good for the greatest number should guide. There is much wisdom in the axiom of our brothers of the Bar that "hard cases make bad law." What they mean is that the disinclination to work a hardship leads to the abandonment of inexorable logic. It will not do to lower our standards in order to avoid working a hardship here and there. Neither the medical schools nor our Associations, neither public spirited Master Surgeons nor informed laymen can make capable surgeons, still less great surgeons, but together they can prevent incompetent men calling themselves surgeons, from visiting their incompetence upon the ignorant and suffering public.

That the public does suffer by the thousands from such men, is common knowledge among us. That it suffers in this manner because it is ignorant, is equally common knowledge among us. But it is not the public that is to be blamed for its ignorance in this respect; nor is the blame attributable merely to an inscrutable and immutable scheme of life. "The fault, dear Brutus, is not in our stars, but in ourselves . . ." For our own sake, for the sake of what has been called "the most brilliant of arts," we must, then, seek to repair this fault, as well as for the sake of the layman who is, or ought to be, our partner in this effort.

So far as law is concerned, it is repeated, any man who holds the degree of Doctor of Medicine and has a license to practice medicine may operate upon and practice surgery upon the layman. Before a lawyer may appear before the Supreme Court of the United States, he must have been licensed for three years to practice before the highest court of his own state. But the young doctor who has had his license to practice medicine for one day may take the body of an unfortunate patient in his hands, and with unskilled scalpel send its soul winging to the last of all Courts.

It is submitted that it is our duty so to inform the layman, to educate him, if we like, that he will not tolerate such a condition. It is our duty to inform him that a considerable percentage of the work done by experienced and capable surgeons is work of repair undertaken for the purpose of saving limbs, organs and often lives desperately endangered by the clumsy and sometimes culpable ignorance of incompetent men.

It is our duty to inform him that one of the most potent causes of blundering surgery is the open hospital, where any doctor may operate who can induce a sufferer to trust himself to his inexperienced hands. It is our duty to inform him that the cause, the foundation itself, of the open hospital, in turn, is the necessity in present conditions that presses upon the hospital's management to keep its beds filled. It is our duty to inform him that the shingle of an M.D. is not at all an assurance that the man in the office before which it swings is capable of practicing surgery—whether he be young, mature, aging, or aged.

If he asks—this layman—how he is to know what doctor is capable of practicing surgery upon him, it behooves us to answer, for the present, that

only such surgeons as are approved by senior surgeons, or by the management of closed hospitals, are to be entrusted with the complicated diagnostic and technical tasks that must be performed by the competent surgeon. It behooves us to tell him, too, that it is for him and his fellow layman to join with us in our effort, our purpose, to see to it that eventually only qualified men shall be legally authorized to practice surgery.

Our layman, being a business man, a man of affairs, may say: "It is all very well to insist that your graduate shall devote so many years to postgraduate study and training and experience, that he will not be permitted to practice surgery without supervision until he is well past the age of 30 years. But who is to support him during those postgraduate years? Why should he be denied the young man's right to marry and rear a family?"

Our answer, I take it, will be: "As our medical schools are constituted now, and as postgraduate work is carried on, the aspiring surgeon must earn, must be helped to earn, a living while he is assistant to a Master Surgeon." After we have grasped a larger measure of that for which we reach, after that superschool of surgery of which we now dream shall have been established, and shall have become prepared to train Master Surgeons, then our layman and his associates must create and maintain foundations whose pecuniary yield will enable the wise and experienced men who conduct this superschool to finance selected men of intellectual distinction, of strong will and of high character, while they pursue their quest of the Master Surgeon's scroll.

Our layman being a man of affairs, who has made his own way, who is familiar with the vigor and energy and courage of youth, may also ask: "Can you, in this idealistic plan of yours, be right in urging that studious and learned, intellectual and even brilliant, academically taught, and scientifically trained men, shall have withheld from them the right to practice surgery alone as Master Surgeons until the first fine flavor of youth has departed from them?"

Our answer, in my judgment, should be: "Yes!" Knowledge is not wisdom. Brilliance is not experience. Courage is not judgment. This is concretely answered by Disraeli when he said: "However gradual may be the growth of confidence, that of credit requires still more time to arrive at maturity."

Knowing how to operate is not knowing when to operate. Diagnostic acumen does not necessarily take into account other factors than the difficulties before the surgeon—factors which must be taken into account by the Master Surgeon. The caution which must go hand in hand with intrepidity, the comprehension which must range far beyond the operative field, the sort of fearlessness that is not afraid of being thought afraid, the wisdom that makes knowledge useful—all these are less the property of fine flavored youth than of full bodied maturity. And all are essential items of the Master Surgeon's equipment.

If by taking earnest thought and by converting that thought into careful

action we can form the Master Surgeon by such a mold as I have tried to suggest, and if the layman in his turn can be brought to realize that only such a Master Surgeon should be authorized to practice the science and art of surgery, then finally we shall have grasped that for which we have been reaching, and the practice of surgery will have become distinctively the province of the Master Surgeon to the incalculable benefit of the layman.

Finally, as tonight represents the crowning episode of my incumbency as your President, it behooves me to say that what little work I have done has been a labor of love. The glamour of high office does not appeal to me, and I would remind those who follow me that the dizzy heights are cold, the valleys warm and cheerful. I would that I had words to thank you again for the great honor conferred upon me.

The iris of the summer's shower, the rosy dawn, the brilliant hues of the bird of Juno are bright, soft things—but blend them, blend all the beauties of Nature in one harmonious whole, and there will still be wanting that mysterious essence of gladness that enters into the heart of man when so richly rewarded by his fellow man. Of all honors greatly to be desired, this to me is the greatest.

In closing, may I ask your forgiveness for a personal allusion. My father, my grandfather, and my great grandfather were all doctors of medicine. As a young boy my interest in medicine carried me into the library of my grandfathers, and there on the inside page of their old volumes I saw written, in the handwriting of my fathers, the following words: "*Esse quam videri.*" Freely translated this means: "To be, rather than to seem to be." To attain to the meaning of this motto has been an obsession of mine since I first began the study of medicine.

Success in the practice of surgery is not a wild dream of technical attainment, nor a madness of desire for professional acclaim. Oh! no, it is not that. It is goodness and honor and sincerity of effort and faith in life. It is this that I am wishing for you and yours.

BRAIN ABSCESS

JOSEPH E. J. KING, M.S., M.D.

NEW YORK, N. Y.

IN THIS paper I shall confine my remarks for the most part to the *treatment* of brain abscesses secondary to infection of the middle ear, mastoid and accessory nasal sinuses, as well as those of traumatic origin. The subject of metastatic brain abscess will not be considered. The etiology, pathology and diagnosis of brain abscess have been adequately covered by Macewen,²¹ Eagleton,¹⁴ Evans,¹⁵ Atkinson,² Adson and Craig¹ and various other writers.

Otogenic abscesses resulting from otitis media and mastoiditis are in the majority, and extension of infection from these sources most frequently involves the temporosphenoidal lobe and the cerebellum. Evans¹⁵ states that 83.2 per cent of brain abscesses are due to spread of infection from otitis media and mastoiditis, and that 9.1 per cent result from infections of the nasal cavity and its accessory sinuses. Only 7.7 per cent arise from all other sources. Therefore, 93.2 per cent of all brain abscesses are actually due to extension of infection from the nasopharynx. He further states that the spread of infection to the brain substance from the middle ear and mastoiditis, by *direct extension*, is through purulent thrombosis of the lateral sinus, osteomyelitis of the tympanic wall, along the adventitial spaces of perforating blood vessels, and through the internal auditory meatus. The spread of infection from the nasal cavity and its accessory sinuses by direct extension is due to osteomyelitis of the sinus wall, along the perineural spaces, and along and through the veins. In addition, the involvement of the brain by direct extension follows trauma of the skull and invasion of the brain by malignant growths.

Regardless of the mode of infection, according to Evans, a brain abscess commences with an inflammatory leukocytic infiltration and softening of the brain substance, and terminates by the conversion of a portion of the brain into a cavity containing pus. In the *acute* form, the abscess has no definite wall. It consists of a broken-down area of brain tissue, which might be termed acute suppurative encephalitis, with a central area containing pus and brain detritus. The wall, if it exists at all, is irregular and ill defined and consists of brain tissue with a shaggy surface, surrounded by an area of edematous brain substance. Should the patient be fortunate, this process becomes *chronic* in that a well defined wall or "capsule" is established, and the abscess then truly follows the old surgical description of any abscess as being "a circumscribed cavity containing pus" (Fig. 1). The wall of the abscess consists of an internal layer composed of purulent tissue, the so called pyogenic membrane, and an external layer of granulation tissue composed of various proportions of fibrous macroglia and all fibrous tissue derived from the vascular adventitia and, in some instances, from the leptomeninges. The granulation tissue is infiltrated with plasma cells, lymphocytes, and a few eosinophile

leukocytes. The infiltration is continued in the adventitia of the vessels for a considerable distance into the brain (Evans). Bagley,³ in 1922, described the formation and pathology of a brain abscess and its wall.

It has not been determined accurately how long it takes for a definite wall or capsule to form. Penfield²³ stated that the wall of an abscess begins to form in the first week, but that it does not offer resistance to a brain cannula till after two or three weeks. Grant¹⁷ stated that a definite capsule or firm wall is

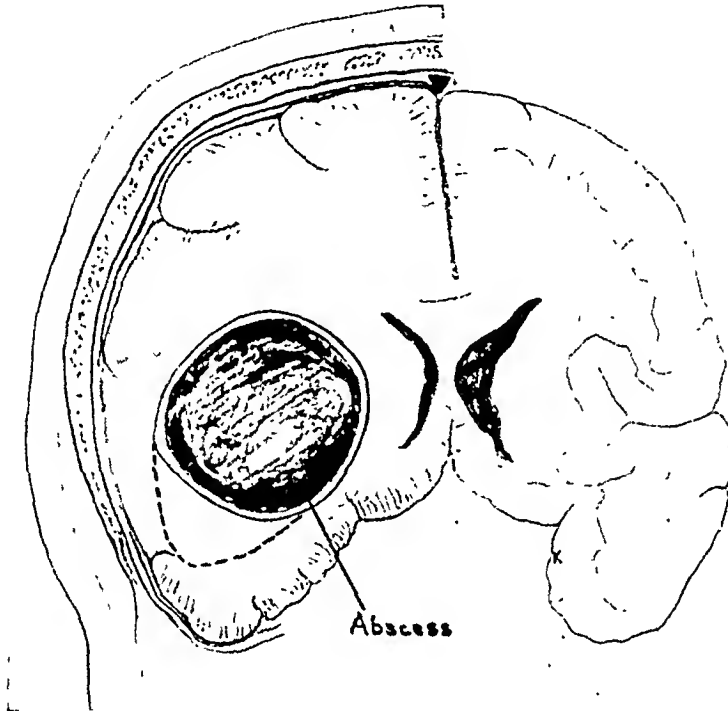


FIG. 1.—Chronic encapsulated abscess of the temporal lobe. The hemisphere which contains the abscess is larger than its mate. The ventricles are markedly compressed. The adjacent ventricle may be completely collapsed. The structures are shifted to the opposite side. The broken line indicates that the proximal pole may extend downward and outward and may form a definite "stalk" fixed to the dura.

well established in the interval between the fourth and sixth weeks, and Bagley showed a section of an abscess wall which formed in three to four weeks. The latter also stated that the thickness and firmness of the abscess wall will be determined by the relative amount of mesoblastic and glioblastic fibrous tissue present, the amount of glial tissue in the wall, and the length of time the abscess has existed.

PRELIMINARY MANAGEMENT.—When a brain abscess is suspected, *stereorontgenographic* examination should be made in order to determine the degree of involvement of the mastoids, ethmoids, frontal sinuses, sphenoidal cells and antra. This may throw considerable light on the neurologic picture. Should infection of the sphenoid coexist with the involvement of the ethmoids and the frontal sinus, and a frontal lobe abscess is properly treated, a subsequent unsuspected abscess in the temporosphenoidal lobe due to sphenoidal infection may develop. The lack of attention paid by many writers to the

eradication of the source or focus of the infection in the middle ear, mastoid, or the nasal accessory sinuses is rather remarkable. Except in a case of emergency, the infectious process or processes in the sites of *extracranial* origin should first be eliminated before the intracranial suppurative process is attacked. Otherwise, following the proper handling of a subcortical abscess, another abscess may develop from the same source. Furthermore, an extradural lesion which may simulate a subdural one may be eliminated without a subdural exploration. In most instances of brain abscess, the drainage of the abscess can be accomplished immediately following the extracranial procedure. In some critical, comatose cases accompanied by marked slowing of the pulse, it may be advisable to evacuate the abscess first and perform the extracranial operation at a later date.

TYPES OF OPERATION.—In a general way the types of operative procedures which have been described may be classified as follows: (1) The closed method. (2) The open method. (3) Extirpation of the abscess *in toto*. (4) Tapping.

Closed Method.—In the closed method, usually a small opening is made in the skull. Some type of drainage tube, *e.g.*, a small rubber tube or a small rubber catheter, is inserted into the abscess cavity without inspection of the cavity, the tube is allowed to remain in place for a considerable period of time, and is slowly removed without any, or but a small, degree of herniation. Coleman,^{8, 9} Grant,¹⁷ Dowman,¹³ Sachs,²⁴ Bagley, McKenzie,²² Atkinson, Davidoff¹² and others have advocated this method with some few changes or special details in the technic being recommended by them. In this method one first locates the "capsule" of the abscess and introduces the drainage material, catheter or tube, into the abscess cavity without intentional leakage of pus into the surrounding brain substance. For this purpose various ingenious devices in the form of guides, directors, encephaloscopes and searchers have been used. Among these is the encephaloscope devised by Whiting, its modification described by Eagleton,¹⁴ and the cannula, sleeve and tube by Grant. Both Grant and Coleman have reported rather large series of recoveries following operation by the closed method. Macewen's use of the decalcified chicken bone drain is well known.

It is difficult to understand how an abscess with secondary extensions, loculations, or of an irregular shape could be properly drained by this method. Moreover, it is believed that the capsule, in the cases of so called recoveries, collapses about the drain as it is slowly removed, leaving a partially obliterated tract with a thick fibrous wall which remains as a potential source of infection. Such an instance was observed in 1919 after an abscess had been drained in this manner. Deep or centrally situated abscesses, however, can be drained only by this method, or by the use of a cannula or searcher.

Open Method.—In 1924,¹⁹ the author advocated a rather wide open approach to the abscess, removal of the overlying cortex and a portion of the presenting capsule, evacuation and irrigation of the abscess cavity, thorough inspection of the cavity, and eventual obliteration of the cavity by its tem-

porary eversion and herniation. This method was advocated following the recovery of a patient in 1920 and of two other patients in 1923 who were operated upon in this manner. Previous to this time drainage tubes had not proven satisfactory for one reason or another, and in the method described they were completely discarded. The principles set forth at that time are still adhered to in general, with some modifications which will be dealt with later in this paper.

In 1925, Cahill⁴ reported a series of cases treated by the use of the Mosher drain which was first considered by Mosher in 1915. The abscess was operated upon in two stages and was entered, in the majority of cases, by the mastoid route. Subsequently, in papers presented in 1929 and 1933, Cahill^{5, 6} advocated a more extensive removal of the brain cortex and capsule of the abscess, so that the drain could be more accurately placed into the abscess cavity. He stated that "the formation of a fistulous tract about the drain to the abscess cavity in part makes the capsule extend to the surface of the brain," which approaches in some degree the method described by the author. In a personal communication, Cahill⁷ described the formation of a small hernia or "nubbin" at the site from which the drain was finally removed in the cases operated on according to his modified method. It is believed that this small hernia represents the remnants of the contracted abscess cavity which has found its way to the surface. Cahill described the use of the Mosher drain in cases of otitic abscess and advocated its use in cases treated by the otologic surgeon.

Horrax,¹⁵ in 1934, described a procedure first advocated by Dr. Cushing 10 or 12 years earlier for certain chronic encapsulated brain abscesses. He termed it "marsupialization." It decidedly belongs to the open method. Horrax made an opening in the skull about the size of a half dollar, a similar opening in the dura, removed the overlying cortex, removed a portion of the presenting abscess wall after partial evacuation of the abscess, fixed the cut edges of the capsule to the galea with sutures, and filled the abscess cavity with gauze lightly packed over a thin layer of gutta percha. Over this packing of gauze another layer of perforated gutta percha was placed and the entire area was covered with dry dressing and bandage. Subsequently the gauze and gutta percha were gradually extruded by herniation of the abscess cavity outward and were finally removed. A hernia cerebri may have developed, but this subsided. The area became covered with granulation and epithelialized. In this procedure thorough removal of the contents of the abscess cavity and inspection of the cavity can be accomplished. With the exception of suturing the edges of the capsule to the galea, this procedure, in general principles, is quite similar to the one proposed by the author. Horrax reports only one death in a series of eight cases operated upon by him according to the marsupialization method. Sachs reported a successful case operated upon by this method.

In 1932, the author²⁰ operated upon a case of temporosphenoidal abscess which had spontaneously ruptured through the mastoid wound. The capsule

of the abscess was almost completely empty, was contracted to about the size of a malaga grape, and was surrounded by a considerable area of necrotic and suppurative brain substance. In this instance the pericapsular necrotic brain was removed by suction, and inasmuch as the small contracted capsule could not be utilized in any manner, it was removed. The central portion of two layers of iodoform gauze was inserted into the resulting excavation in the temporosphenoidal lobe, and strips of soft iodoform gauze were packed into the cavity against the two layers of iodoform gauze, in the manner of a Mickulicz tampon, until the entire excavation was gently but snugly filled. Dakinization of the wound was carried out and the superficial dressings were changed daily after the first 48 hours. The iodoform gauze packing was slowly pushed out by the gradual herniation of the excavated brain surface and a portion of it was removed each day until none remained. The two layers of iodoform gauze were carefully removed from the brain surface which had herniated to the level of the skull. The area granulated over and healed. Later excision of the scar with approximation of the scalp edges was accomplished.

Since this time iodoform gauze has been used in a similar manner both in encapsulated and non-encapsulated abscesses, and in one instance in which there was a considerable amount of pericapsular brain suppuration and necrosis similar to the case described above.

Adson and Craig, in 1935, described a procedure somewhat similar to those advocated by Horrax and the author. They made an opening in the skull about 3 cm. in diameter, sutured the meninges and the cortex together, to prevent separation of the cortex from the dura, opened the dura by a crucial incision, so as to expose an area of cortex about 2 cm. in diameter, and then sealed the meninges to the cortex by electrocoagulation. After aspiration of pus from the abscess cavity, followed by gentle irrigation with saline solution, the capsule of the abscess was opened with the electrosurgical needle. This allowed of inspection of the abscess cavity aided by an illuminated retractor. Two rubber tubes, sections of a No. 18 F. catheter, were inserted into the cavity and about these strips of iodoform gauze were loosely packed. These strips of gauze were shortened and removed by the tenth day, leaving the two tubes in position. One of these tubes was shortened every other day, while the other one was removed gradually as the sinus closed in and forced it out. The time required from four to six weeks. They stated that there was but one death in 15 consecutive cases of supratentorial abscesses and one death in three cases of cerebellar abscesses. One may judge from the description of their procedure that the approach to, and inspection of, the abscess cavity classify it as an open method, while the use of drainage tubes with the formation of a sinus might place it in the category of the closed method.

It may be deduced that the operative procedures proposed or devised by Cahill, Horrax, Adson and Craig and the author have many similarities in principles though they may differ in details of technic.

Extirpation.—Various writers have reported an occasional case in which an old chronic abscess has been completely extirpated. Most of these were probably removed after an osteoplastic flap had been turned down in exploration for a tumor. Adson and Cairns report such instances. I am not acquainted with anyone who advocates routine extirpation of diagnosed abscesses, although one of the French surgeons stated that he did. When the abscess is of long standing, has a very thick wall, is calcified or contains thick inspissated pus, extirpation without opening the abscess might be considered. Or in a case of spontaneous evacuation of an abscess cavity, which is surrounded by suppurative necrotic brain tissue (as in the case which I have reported above), extirpation would then have to be done for the reason that it cannot be utilized.

In the instances of large abscesses which closely approach the ventricle, extirpation would surely be followed either by rupture into the ventricle, or rupture from the ventricle outward due to the increasing intraventricular pressure. I feel that the major and inner portion of the capsule should be preserved as a barrier and serve to prevent such a catastrophe.

Tapping.—Dandy,^{10, 11} in 1926, and again in 1932, advocated tapping only in cases of chronic abscesses. He introduced a ventricular needle through a small trephine opening and a tiny nick in the dura into the abscess cavity and left the needle in place until the pus ceased to drip. He neither aspirated nor irrigated the cavity, but withdrew the needle and closed the scalp incision tight. He stated that "many times a single release of pus has been necessary; on fewer occasions two or more taps have been required."

I have had no experience with this method. The fact that it is not used by many authors who have reported a fairly large number of recoveries would seem to indicate that tapping is not generally used. Recently I saw sections of three brains which had been removed from patients who had been operated upon consecutively by one of my colleagues according to this method. He told me of the autopsy findings in a fourth case. He has given up the use of this type of operation. In passing, it might be said that the use of the osteoplastic flap in connection with the operation for brain abscess in general is not used and should not be advised.

It will thus be seen that there is wide divergence of opinion regarding the proper approach to, and the method of drainage of, an abscess of the brain, although most writers agree that the operation should be done after the abscess has developed a substantial wall or capsule. It is believed that no single procedure or combination of operations will result in 100 per cent recoveries. All abscesses are not alike; therefore, no one procedure will suffice in all cases.

SURGICAL TECHNIC.—Anesthesia.—Local anesthesia, novocain 1 or $\frac{1}{2}$ per cent solution with suprarenin alone or combined with avertin, is preferred. With adults, especially those who are stuporous or semicomatose, local anesthesia alone will suffice. With children the combination of avertin and novocain is more satisfactory. The use of ether is not advised for the

reason that it increases intracranial pressure while avertin decreases it. Vomiting following ether administration may produce damage to the abscess wall or result in rupture of the abscess into the ventricle. Ether also increases bleeding.

Procedure.—The vast majority of all cerebral abscesses in my experience have approached the dura at a point where it can be attacked at a depth which varies from $\frac{1}{2}$ to about 3 cm. Inspection of museum specimens shows similar findings. Therefore, the approach to the abscess, as advocated in my original paper, with the modifications in technic to be described, will allow of adequate drainage of the majority of cerebral abscesses, whether the source of infection originates from the mastoid region and middle ear, the nasal cavity and accessory sinuses, or trauma. As stated above, the source of the intracranial infection should be eliminated before operation for the abscess, except in traumatic and in certain critical or extremely grave cases.

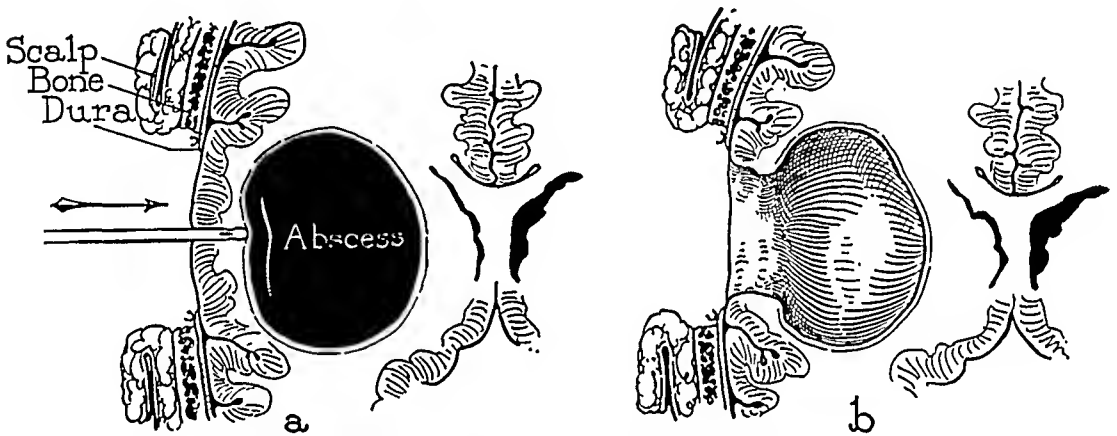


FIG. 2.—(a)—A cranial and a dural opening have been made directly over the abscess. The dural margins are fixed to the meninges and cortex by electrocoagulation and interrupted fine catgut sutures. The cannula inserted into the brain substance meets with resistance not unlike that of a thin rubber ball. (b)—The overlying cortex and a portion of the wall of the abscess have been removed. The cavity can be inspected thoroughly. Fixation of the dura to the meninges and cortex prevents spreading of infection into the meninges.

In a case of temporosphenoidal lobe abscess, a short, straight, slightly oblique incision about one and one-half inches is made through all the soft parts down to the outer table of the skull. An opening with a bone drill is made at a point about one inch posterior to and about one and one-half inches above the external auditory meatus. A small self-retaining retractor gives adequate exposure and controls bleeding. A small nick is made in the dura and a specially devised blunt cannula of small caliber is introduced and passed directly inward and slightly downward. When the end of the cannula comes in contact with the wall or capsule of the abscess (Fig. 2-a), resistance similar to that offered by a thin-walled rubber ball is encountered. It is preferred that the cannula should not enter the abscess cavity. It is not necessary, and spreading of infection is obviated while preparation for drainage of the abscess is being made. When the wall of the abscess cavity is located, slow tangential insertions of the cannula will help to ascertain the location and approximate size. By means of the cannula it can be determined whether the abscess is situated more anterior, superior, posterior or inferior to the

opening in the skull. When the position of the abscess is determined, the mastoid incision is extended upward over the ear at a distance of about half an inch from its attachment. The oblique straight incision is connected with it and the three scalp flaps thus defined are dissected up from the pericranium and held with self-retaining retractors. The anterior flap carries the ear downward and forward out of the way. This exposes an area of pericranium about 3 or 4 cm. in diameter depending upon the size of the abscess. The bony opening in the skull is enlarged in a circular manner to about the size of a silver dollar and in the direction necessary to place it directly *over* the abscess. The pericranium is removed from the outer table of the skull only sufficiently to permit making the proper sized opening in the bone, and is not stripped off from the outer table of the skull for any distance beyond the bony opening. In some cases where the abscess extends low into the temporo-sphenoidal lobe it may be necessary to remove the bone downward into the mastoid wound. The dura is incised in stellate manner to within about one-quarter of an inch of the bony margin of the defect and the dural flaps are excised. This leaves a circular opening in the dura slightly smaller than the bony opening into which the cortex bulges. The cortex is fixed to the dura by means of interrupted sutures of fine plain catgut as suggested by Adson, and the dural margin, meninges and cortex are fused by means of electrocoagulation. The three narrow strips of iodoform gauze which were formerly inserted beneath the dura, between it and the cortex, to prevent spread of infection into the subdural space, are no longer used in this manner but are placed in a tangential position about the bony opening to cover over the edges of the bone and dura. The subsequent oozing of blood into this gauze followed by clotting of the blood fixes the gauze to the bony and dural margins and forms a mechanical barrier against the spread of infection. The overlying brain substance is removed by means of the electrosurgical unit and suction to expose an area of the wall of the abscess about the size of a quarter or a two-franc piece, depending upon the size of the abscess. Should pericapsular necrotic and suppurative brain substance be present it can readily be removed by suction. This necrotic brain material if encountered is usually external to that portion of the capsule which is exposed, but it may extend laterally about the capsule. As the overlying brain substance is removed, the capsule comes into view and presents itself like the end of an egg. An aspirating needle is inserted into it and a small amount of the pus is removed in order to lessen the intracapsular tension and is preserved for laboratory examination. The capsule is then opened with the electrosurgical needle and the pus is removed by suction. The outer presenting portion of the capsule is next removed in a circular manner so that the complete interior of the abscess cavity can be inspected (Fig. 2-b). Should an opening into an extension of the abscess be found, a sufficient portion of the capsule is removed to convert both into one cavity. After the pus has been removed and the cavity cleaned the inner wall will appear rather smooth, but may have thin flakes of inspissated pus loosely attached to it. These can

be easily removed under direct inspection. By this time it will be observed that the depth of the cavity is not so great as when the cavity was first entered. The floor of the cavity will have progressed upward toward the operator or outward toward the opening in the skull. This lessening in depth varies from about one-quarter to one-half inch in the cases which have been observed. This elevation or outward progression of the floor of the abscess after the outer portion of the capsule has been removed is due to release of pressure from within the abscess, followed by increase in the size of the compressed ventricles.

The central portion of two layers of iodoform gauze, about six inches square, is introduced into the abscess cavity (Fig. 3-c), and strips of *soft* iodoform gauze are gently but rather snugly packed against the two layers of iodoform gauze so that the two layers of gauze come in intimate contact with the wall of the entire cavity (Fig. 3-d). The packing is continued until the

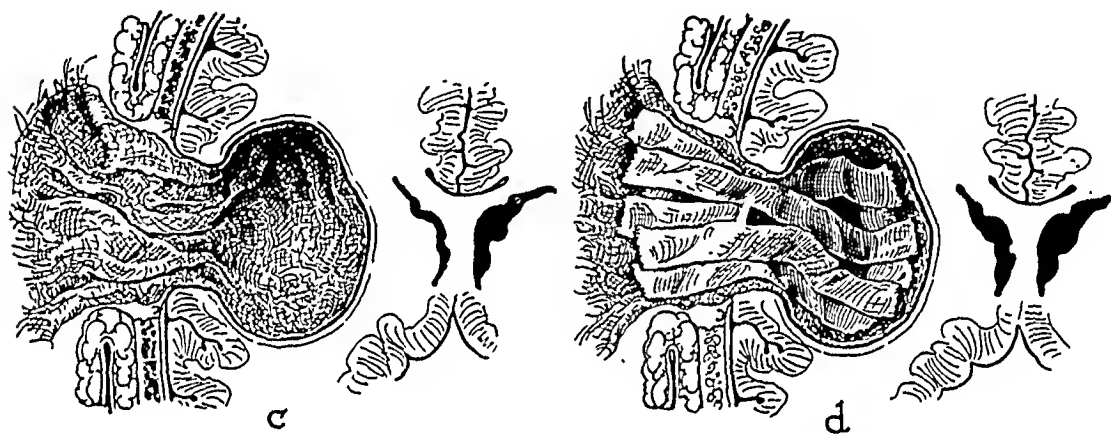


FIG. 3.—(c)—The central portion of a pack consisting of two layers of iodoform gauze have been inserted into the abscess cavity and the free edges have been brought out through the openings in the dura and skull. (d)—Narrow strips of soft iodoform gauze have been gently packed into the soft pack so as to bring the two layers of gauze into opposition with the inner walls of the cavity and the tract through the cortex.

tract is completely filled to the level of the skull, and the loose margins are folded over the packing. The self-retaining retractors are removed, bleeding points are controlled by electrocoagulation or suture ligation if necessary, and fluffed iodoform gauze is loosely stuffed beneath the flaps. The open end of a small rubber irrigating tube is carried within the overlying gauze, and a wet azochloramid gauze dressing is applied and held with a bandage which includes the lower jaw so as to prevent displacement of the dressing.

AFTER TREATMENT.—Dressings.—The first dressing is done after 48 hours. All the dressing down to the incision is removed and replaced. Meanwhile instillation of azochloramid solution into the superficial dressing in the wound is made every two hours. (Azochloramid solution is used now in place of Dakin solution for the reason that it is more prolonged in action, does not irritate the scalp so much as Dakin solution, and is readily obtainable and easily prepared.) On the third day the iodoform gauze packings in the external portion of the wound beneath the flaps are loosened and wet with the solution. This allows of slight progression outward of the iodoform

gauze in the brain abscess cavity proper. At daily dressings the narrow gauze strips are gradually removed from the operative wound and from within the iodoform packing lining the abscess cavity (Fig. 4-e). On the fifth day the iodoform gauze strips are removed from about the bony margin. By the tenth day the floor of the abscess cavity will have become elevated sufficiently to extrude and allow complete removal of the gauze within the cavity. The last two layers of iodoform gauze are slowly and carefully removed. While doing this it is well to use a rubber ear syringe with a soft tip and hydrogen peroxide. Where the wall is but weakly encapsulated the gauze will have become firmly adherent to the floor of the abscess, and must be very slowly and carefully removed, otherwise the surface of the brain will be torn. This is not the case when the abscess is well encapsulated.

Rapid herniation of the abscess cavity is no longer advised nor permitted. It is necessary only to allow the floor of the abscess to reach the level of the

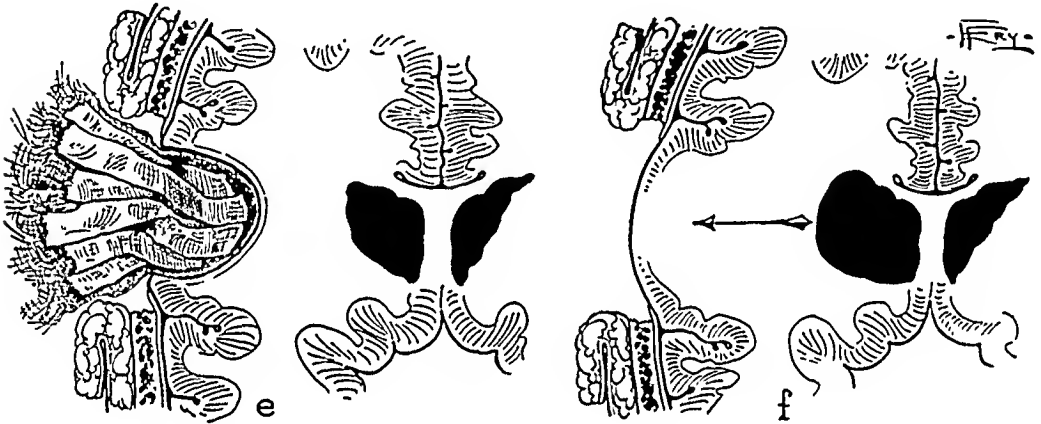


FIG. 4.—(e)—The gauze strips have been slowly shortened at successive dressings accompanying slow and gradual elevation of the floor of the cavity. This controlled herniation outward is due to accumulation of fluid in the ventricles with slow removal of the gauze. (f)—The floor of the cavity is maintained at the level of the skull by lumbar punctures, should they be necessary. The remnants of the abscess wall become a part of the scar tissue at the operative site. The margins of the bony defect become covered with granulation tissue and the scalp flaps are allowed to fall over and become adherent to the area. Development of an actual hernia cerebri is *not* allowed.

skull or near the level of the skull (Fig. 4-f). This slower outward progression of the floor of the abscess which reaches completion by the tenth day is controlled by lumbar punctures done as often as is necessary. It is also due in a considerable degree to the fact that the gauze is maintained in position in the cavity. Iodoform gauze for this purpose has proved to be of greater value than the rubber dam formerly used. Meanwhile, the scalp flaps have been allowed to fall back into position and become attached to the underlying tissues.

The iodoform gauze which was placed in the mastoid wound is removed on the sixth day and thereafter changed every other day. In the case where a mastoidectomy has been done simultaneously with evacuation of the abscess, the removal of the squamous portion of the temporal bone between the site of the operation for the abscess and the mastoid process is usually done, for the reason that this bone is frequently involved. The dura in this region is

kept intact. Since overherniation or development of a hernia cerebri at the site of operation is not allowed, the difficulty formerly offered by the overhanging hernia into the mastoid wound does not exist. The area now becomes rapidly covered with healthy granulations followed by epithelialization. In order to permit more rapid spread of epithelium across the surface, the scalp about the wound is kept well shaved and the granulating area is covered with strips of perforated adhesive placed across from one scalp flap to another. After the area has been covered with adhesive strips, irrigation of the wound is discontinued and a dressing of wet azochloramid gauze is applied.

In this type of abscess the patient should be out of bed after about 16 days, should be able to leave the hospital about the end of the third week, and the wound should be completely covered with epithelium within four or five weeks. After about six months to a year I have usually performed a scalp plastic in order to cover the area more securely with normal scalp. This affords better protection and prevents excoriation of the scar, especially in summer. Most of the scar following the plastic procedure is in the hairline, and that portion behind the ear over the mastoid region is rendered less conspicuous.

Usually the postoperative temperature reaches its highest point, about 101.5° or 102° F., on the first or second day postoperative, and after a few days recedes to normal.

Lumbar Punctures.—Lumbar punctures can safely be done on the third or fourth postoperative day, and thereafter as often as is necessary to prevent elevation of the floor of the abscess beyond the level of the skull. When the abscess is very large it may be necessary to resort to a lumbar puncture daily. In one instance where the abscess cavity contained more than seven ounces of pus and in which later ventricular distention was rapid and considerable, daily lumbar puncture was done with removal of from one and one-half to two ounces of fluid. Removal of too much fluid will produce a negative pressure in the ventricle with resultant headache, while removal of too small an amount will result in bulging of the floor of the cavity. It should be remembered that recession of the floor continues to some extent after removal of the fluid; therefore the needle should be withdrawn when the floor of the cavity is at the level of the skull. Headache will thus be obviated.

General Care.—The head of the patient is kept elevated, at first on one or two pillows. On the third day the patient is placed in a semisitting position. Fluids are readily taken after the patient has recovered from the anesthetic. It has not been necessary to give tubal feeding, and intravenous administration of glucose is not necessary. It is important that the bowels should move well daily. An enema is given every morning, and a mild saline laxative or cathartic at night should this be necessary. When the bowels have not moved well, it will be noticed that the brain surface tends to bulge, while the reverse is true if the bowels have been properly evacuated. Usually the patient complains of very little pain. For restlessness hypodermic administra-

tion of sodium luminal, or administration of chloral hydrate by rectal instillation, is advised.

ADVANTAGES OF THE PROCEDURE.—(1) It allows direct approach to the abscess with some spillage or leakage of pus *on to* but not *into* brain substance, with avoidance of secondary suppurative encephalitis. With the wide open wound containing iodoform gauze kept wet either with Dakin or azochloramid solution, necrosis of the brain accompanied by suppuration does not occur. In fact, no actual pus is seen after complete evacuation of the abscess.

(2) Removal of the outer wall of the abscess allows complete inspection and cleansing of the abscess cavity so that a secondary pocket or an extension, should it exist, can be properly dealt with and drained.

(3) Cerebral and medullary compression are relieved by direct evacuation of the abscess, and recession of edema of the brain due to the open drainage avenue. Slow herniation, or progression of the floor of the abscess outward carrying the iodoform gauze with it, prevents compression during the time of rapid intraventricular accumulation of fluid.

(4) Should pericapsular brain necrosis coexist, it can easily be seen and the necrotic brain substance can be removed by suction.

(5) Meningitis does not occur (unless it already exists) by infection spreading to the meninges, for the reason that the meningeal spaces about the wound have been sealed off before the pus is evacuated.

(6) The disastrous results from ventricular perforation by a drainage tube, or dislodgment of the tube are avoided, because no tubes are used.

(7) When iodoform gauze is kept in contact with the inner surface of a non-encapsulated, or a weakly encapsulated abscess for a period of ten days, a definite protective fibrous layer develops on the surface or wall.

(8) Secondary pockets do not occur inasmuch as the remainder of the abscess is carried outward to, or about, the level of the skull, at which level it is maintained by lumbar puncture. The entire infected area is brought to the surface and is maintained at this level (Fig. 5). Multiple operations are obviated. The remaining portion of the capsule becomes a part of the scar tissue area at the operative site. Therefore, no scar tissue tract or closed sinus, with thick wall which might later act as a focus for recurrence, remains within the brain substance.

(9) Rupture of the ventricle from within outward, and overherniation are prevented by lumbar puncture. By inspection of the area under direct vision, one can determine the proper amount of fluid to be removed.

(10) The stuporous, semicomatose or comatose condition of the patient is relieved almost immediately and it does not recur. Therefore, early giving of fluids and food without having to resort to tubal feeding is carried out. This prevents choking and coughing which otherwise attend taking of food by a stuporous patient in the absence of tubal feeding.

(11) The procedure can be utilized in the majority of cerebral abscesses, and not only in small superficial abscesses as may be inferred from an illustration in my original paper.

These advantages are likewise obtained in the operation described by Horrax in those cases where it can be used. It can be used only in cases where there is a definite chronic abscess wall, and where the edges of the capsule can be brought out sufficiently to permit of suture to the galea.

CRITIQUE OF THE PROCEDURE.—(1) It cannot be utilized in cases of small, deep, and centrally placed abscesses. This is self-evident. One should be highly gratified if such an abscess could possibly be located, and still more so if it could be drained by any means. A small catheter introduced through the apparatus devised by Grant would be probably the method of choice.

(2) It should not be used in cases of cerebellar abscess except in those

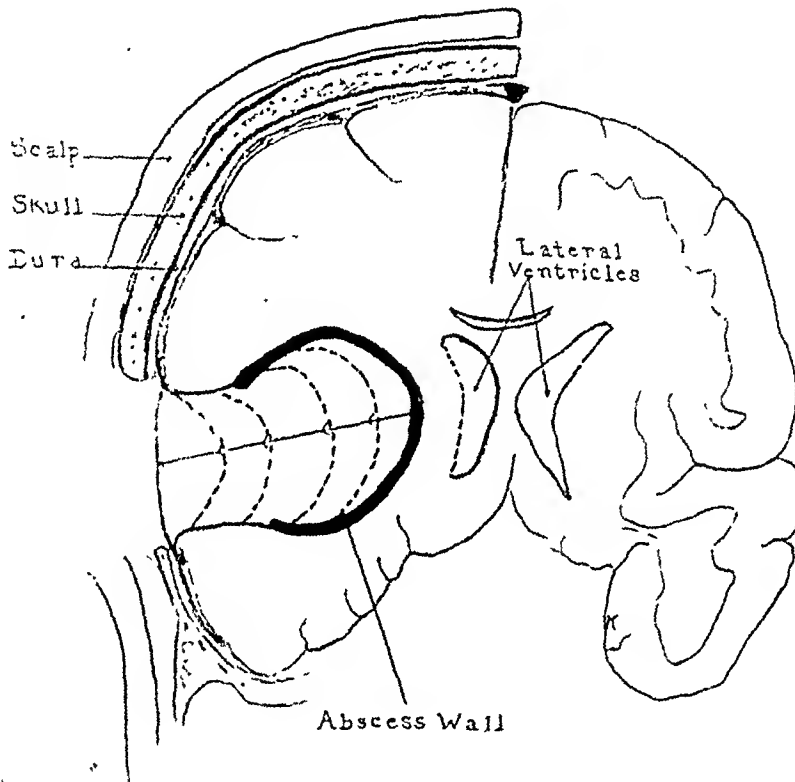


FIG. 5.—Illustration shows the gradual outward progress of the floor of the abscess cavity to the level of the skull, where it is maintained. One or more lumbar punctures may be necessary. The adjacent ventricle becomes markedly dilated, the opposite ventricle becomes moderately dilated. Shifting to the opposite side ceases and regression takes place.

in which the abscess is located completely within the cerebellar lobe, without being fixed to the petrus or dura.

(3) Objections have been made to the removal of a portion of the cortex overlying the abscess. There has been no instance of *production* of aphasia, mental deterioration, epileptiform attacks, or paralysis.

(4) Objection to the overherniation advocated in my original paper is proper. Not only was it unnecessary, but it required a longer period of time for eventual subsidence of the hernia and healing of the wound. Marked herniation is not allowed. When the floor of the cavity has reached the level of the skull, everything desired from herniation has been accomplished.

FRONTAL LOBE ABSCESS.—In the vast majority of cases abscesses of the frontal lobe follow infections of the nasal cavity and the accessory sinuses, with or without osteomyelitis of the frontal bone. They are usually ovoid in shape with the smaller end directed forward when the source of infection is the ethmoids or the frontal sinus. Most of them have but a small area of brain substance intervening between the anterior portion of the abscess wall and the inner table of the skull (posterior wall of the frontal sinus or ethmoids), and some may have perforated and drained into the nasal cavity. Those which develop secondary to osteomyelitis of the frontal bone are more likely to be spheroid. Eradication of the extracranial source of infection should be accomplished in all cases where the general condition of the patient will permit. Provided a definite diagnosis and localization of a frontal lobe abscess has been made, operation upon the frontal sinus and ethmoids, if necessary, should be done by the rhinologic surgeon and followed immediately by operation upon the abscess. If osteomyelitis of the frontal bone coexists, the complete operation for this condition according to a modified Furstenberg¹⁶ procedure should be carried out. After removal of the involved frontal bone, an extradural pus pocket may be found. An opening through the dura leading into a subdural or subcortical abscess may be seen. If so, the abscess should be opened immediately. Otherwise, opening of an intact dura is better deferred unless one is certain that a subcortical abscess is present.

The incision begins in the outer extremity of the eyebrow, extends inward through the eyebrow to its inner extremity obliquely upward and inward to the midline of the forehead at the root of the nose, from which point it is carried vertically in the midline to within the hairline and thence downward for about two or two and one-half inches toward the temporal region. The flap consisting of all soft parts, except the pericranium, is turned down. The pericranium is included in the flap in cases of osteomyelitis of the frontal bone. This incision allows one to clean out the frontal sinus with preservation of the supra-orbital ridge, and to evacuate the frontal lobe abscess. Should it be necessary to exenterate the ethmoids, a short curved incision extending from the inner inferior angle of the incision is carried downward over the ethmoid region. The free end of the flap is turned underneath, thus folding the flap on itself, and is sutured loosely with the denuded surfaces approximated. This keeps the flap out of the way, controls bleeding from it, and prevents it from shriveling, as otherwise it would do if left free. After the floor of the abscess has herniated to the surface of the skull, it is maintained at this level by lumbar punctures, should they be necessary. When the surface has become firm and well granulated or covered with epithelium, the flap is unrolled and replaced in position. After healing, the only portion of the scar which can be seen is that in the midline. This is scarcely noticeable and may be altogether lost in the vertical wrinkles of the forehead. The other portions of the scar are within the eyebrow and the hairline and are not seen.

Should osteomyelitis of the frontal bone be present, the infected bone is removed according to a modified Furstenberg method through the same incision carried farther back of the hairline. Operation upon the frontal sinus and the ethmoids is done should it be necessary.

Most frontal lobe abscesses are fairly large, ovoid in shape, with the smaller pole directed forward and the larger backward. The wall of the abscess is thickest and toughest about its anterior pole where it approaches the cortex and dura. It is thinnest at the posterior pole which represents that portion of the abscess in its farther progress backward into the white substance of the brain. Should the abscess lie in the medial inferior portion of the frontal lobe, internal to the anterior horn of the lateral ventricle, it will collapse almost immediately after evacuation to such an extent that it is difficult to insert anything into the cavity without injuring its wall. In such instances, a fine meshed silver wire basket covered with a perforated rubber glove finger inserted into the cavity will serve to lead or guide the floor of the cavity to the surface and prevent collapse and subsequent pocketing. Herniation in this type of abscess will be marked if not controlled by lumbar puncture done after 48 hours. If the abscess is located in the outer upper portion of the frontal lobe external to and above the anterior horn of the lateral ventricle, it will not collapse readily. It is treated in the manner similar to that described for temporosphenoidal lobe abscess.

Although diagnosis of brain abscess is not discussed in this paper, the paralysis or paresis produced by frontal lobe abscess will be briefly considered. A large abscess situated in the outer upper portion of the lobe external to the anterior horn of the lateral sinus produces in its progress backward (if not operated upon) contralateral *paresis* of the upper extremity, then the lower extremity, and lastly the face. Such an abscess *per se* seldom produces paralysis for the reason that it is usually evacuated before this can occur, or it spontaneously ruptures into the ventricle. A sudden flaccid contralateral hemiplegia in which the patient's mental condition is not changed may be due to perforation of the posterior wall of the frontal sinus through the dura with extension of the infection upward and backward over the cortex along a narrow tract with formation of a well walled off subdural collection or pocket of pus over the motor area. In such an instance the spinal fluid cell count may be only six or eight. This paralysis clears up in about 48 hours after drainage of the walled off pocket of pus. In a case of suspected abscess, a sudden adverse change in the patient's mental condition either to stupor or coma, accompanied by high elevation of temperature and hemiplegia which develops rather rapidly and completely, is most likely due to rupture into the meninges with rapid spreading of pus over the cortex (massive suppurative leptomeningitis). A small superficial abscess situated in the anterior pole of the frontal lobe will more likely rupture and produce such a picture than a larger abscess which has progressed backward into the white substance of the brain.

CEREBELLAR ABSCESS.—A ventricular puncture should be made before an operation is performed for cerebellar abscess in order to lessen the intraventricular pressure, decrease the likelihood of jamming the conus into the foramen after evacuation of the abscess, and allow one to control the intraventricular pressure during convalescence. This puncture is advisedly made over the anterior horn of the right side for the reason that it gives good access for subsequent tapplings of the ventricle and places the site of puncture away from the likelihood of infection.

In instances where a mastoid wound is not present, the approach to the abscess is made behind the lateral sinus. This allows clean exploration in case of negative findings. It also gives adequate exposure of the abscess if found. In the event that the lateral sinus has been opened for an infected thrombosis, or the abscess has perforated through the mastoid antrum or the lateral sinus, approach through the infected area would then be advisable. The procedure which I have described for cerebral abscess is advocated in the cases where the abscess is located centrally within the cerebellar lobe and is not fixed anteriorly to the petrus or dura. Such abscesses are more or less globular in shape and are in the minority.

Most cerebellar abscesses are located on the anterior inferior surface of the cerebellum and project into the lobe. They are usually quite ovoid in shape and resemble an elongated bird's egg. The smaller thickened pole of the capsule is attached to the dura or the petrus and is so fixed that no herniation can occur. In this type abscess the posterior pole of the wall or capsule of the abscess is exposed after the dura has been fixed to the cerebellum by sutures and electrocoagulation and removal of the overlying cortex by suction. A portion of the capsule about the size of a dime is removed with the electrosurgical needle, the cavity is washed out and inspected and two small rubber drainage tubes (Dakin tube size with a lateral perforation near the distal end) are inserted into the cavity to the full extent. The ends of the two tubes will completely fill the pointed distal extremity of the abscess cavity, while the remaining portion of the capsule will collapse about the tubes. No secondary pocket will develop. The opposite is the case when drainage tubes are placed in a frontal or temporosphenoidal lobe abscess cavity for the reason that the smaller pole or portion of the cavity is directed toward the operator and the larger pole of the abscess is toward the ventricle. The cavity may not collapse equally about the drainage tube, and a secondary pocket is likely to develop.

The incision in the scalp is closed at either extremity. The two tubes are brought out through the middle portion of the incision and about these the wound is loosely packed with iodoform gauze within the bony opening. The two tubes are fixed to the scalp to prevent displacement. In this type abscess there is no danger of perforation by the tubes. In subsequent dressings the tubes are irrigated with azochloramid solution, are allowed to remain in position for about three weeks, and then are gradually shortened until they are completely removed.

TRAUMATIC ABSCESS.—In cases of traumatic abscess, especially those secondary to compound, depressed fracture of the skull, the meninges have already become adherent and fused so that entry to the abscess cavity can be done without transgression of the meningeal spaces. Approach should be made through the scar tissue overlying the abscess where these spaces are obliterated without entering the free subdural or subarachnoid space. By so doing spreading of infection to these spaces and retraction of the cortex after evacuation of the abscess are not likely to occur. Should a foreign body be present within the cavity it is removed. Other foreign bodies lying without the abscess cavity in the brain had better be left unmolested at this time for fear of producing suppurative encephalitis. Should the abscess extend from the vertex downward to a depth below the level of the lateral ventricle, it will rapidly collapse after evacuation, so much so that it will be difficult to introduce any type of drain. Inasmuch as the cortex has already become firmly fixed to the dura, however, lumbar puncture may safely be done at the time of operation. As the cerebrospinal fluid is gradually removed through the lumbar puncture needle, one will observe that the abscess cavity enlarges again so that it can be thoroughly inspected. After this is done, iodoform gauze or plain gauze dipped in azochloramid oil is packed loosely into the cavity in the manner described. Intraventricular pressure is controlled by lumbar punctures, and the floor of the abscess cavity is allowed to progress slowly outward until it appears as a small dimple in the wound. This area granulates over and heals. In these cases the opening in the abscess may not be made as large as in the cerebral abscesses due to infections from the mastoid region or the nasal cavity and its accessory sinuses, for the reason that one desires to limit the size of the opening to the definitely sealed off region of the meninges. Although the duration of convalescence may be more prolonged, these cases can be gotten out of bed sooner than those with the usual type of abscess.

RESULTS

The rather numerous cases of fistulae and sinuses in the brain and traumatic abscesses developing about foreign bodies which were observed in military service in both Germany and the United States will be excluded.

Although a case was operated upon unintentionally in the manner described, in 1920, the procedure was not actually advocated until 1923. Nevertheless, all cases operated upon or seen by the author since 1920, with the exception of several cases of metastatic abscess, will be reported.

Thirty-two cases have been seen. Death resulted in the following groups of cases:

Three of the early cases in which a drainage tube was used; in one of which the tube perforated into the ventricle; in one the tube was dislodged and was replaced by an assistant into brain substance instead of into the tract; and in the third a secondary pocket ruptured into the ventricle.

One case in which a Mosher drain was used; cerebellar.

One case of acute abscess which was aspirated. The patient was moribund when seen; no drainage used.

Four cases of multiple abscess in which the second abscess was not located after operation upon one abscess, or in which a subcortical abscess was associated with a drained subdural pocket of pus.

One case of acute abscess associated with sinus thrombosis and blood stream infection.

Two cases operated upon for extensive suppurative leptomeningitis in which the presence or location of abscess was not determined.

One case of extensive suppurative leptomeningitis in which the presence and location of abscess was known before operation, but permission for operation at the time was not given. Moribund when explored.

One case of coexisting insufflation pneumonia following taking of food in a semicomatose condition. Moribund when explored.

One case in which the patient tore off the dressing and lacerated the hernia cerebri with her finger nails. Followed by infection of the brain.

One case, a child, of postoperative pneumonia.

Two cases without operation: one a few moments after being seen; cerebellar: the other 15 minutes before being seen due to spontaneous rupture of frontal lobe abscess into the ventricle.

Five of the fatal cases probably would have survived had proper management been carried out. The patient who removed the dressing was not under the operator's supervision, having been operated upon in a distant hospital. The child who developed pneumonia did so as a result of being dakinized and left by an open window. One child should have had a good chance of recovery had he been operated upon when the diagnosis was made, but permission was refused by both parents and physicians. The abscesses in two cases, associated with a subdural pocket of pus and a subcortical abscess respectively, which had previously been operated upon, probably could have been well localized and drained had ventriculograms been made.

Only three of the 18 cases enumerated above, in which a single abscess was present, were operated upon by the method advocated. All three were readily located, were well encapsulated, and were acceptably operated upon. One of these had insufflation pneumonia and was moribund when seen. Another is the patient who tore off her dressing, and the third is the child who died of pneumonia.

Three of the 17 cases in which the abscess was single, and who were operated upon by the method advocated, died, making a mortality rate of 17.5 per cent for this procedure. There was only one death in the last ten cases of this type consecutively operated upon.

Of the 14 cases which survived (Table I), the largest abscess contained more than seven ounces, and the smallest single abscess was about the size of a golf ball. The average size was about that of a lime or small tangerine. Five of the cases were either comatose or semicomatose at the time of opera-

BRAIN ABSCESS

tion. Four cases developed cerebrospinal leakage through the hernia cerebri, but with dakinization meningitis did not develop. None of these cases developed epilepsy following operation. One case, that of traumatic abscess in the parietal region, had epileptic attacks both before and following operation. No case had a permanent paresis or a hemi- or monoplegia following operation. Four cases operated upon by a colleague according to the principles set forth in this paper recovered; these cases are not included in this series.

TABLE I
RECOVERED CASES OF BRAIN ABSCESS

Case	Age	Sex	Source of Infection	Location	Pericapsular Brain Necrosis	Infection	Approximate Size
M. L.	28	M.	Mastoiditis with mastoidectomy	Left temporal lobe	None	<i>Streptococcus</i>	Tangerine
T. W.	46	M.	Infected C. C. F. of right frontal sinus	Right frontal lobe	None	<i>Streptococcus hemolyticus</i>	Duck egg
C. D.	26	M.	Mastoiditis with mastoidectomy	Left temporal lobe	Fairly well marked	<i>Staphylococcus aureus</i>	Tangerine
A. S.	22	M.	Infected C. C. F. of skull (gunshot)	Right parietal region	None	<i>Staphylococcus aureus</i>	Golf ball
G. F.	20	M.	Frontal sinusitis left	Right frontal lobe	None	<i>Staphylococcus aureus</i>	Large hen's egg
H. W.	19	F.	Mastoiditis with mastoidectomy and previous operation for brain abscess	Left temporal lobe	Mild	Not recorded (mixed infection from drainage tract)	Multiple (2) each size of malaga grape
C. B.	15	F.	Frontal sinusitis, bilateral; radical operation. Osteomyelitis of skull; operation	Right frontal lobe	Mild	Nonhemolytic streptococcus	Long-drawn-out hen's egg
P. M.	28	M.	Mastoiditis	Left temporal lobe	None	<i>Streptococcus mucosus capsulatus</i> and <i>B. coli communis</i>	Small orange
C. A.	6	F.	Mastoiditis	Left temporo-frontoparietal lobes	None	<i>Streptococcus hemolyticus</i>	Large orange, more than 7 ounces
L. N.	45	F.	Mastoiditis with mastoidectomy	Left temporal lobe	Marked	<i>Streptococcus hemolyticus</i>	Collapsed; spontaneous rupture into mastoid wound
L. B.	55	M.	Frontal sinusitis, ethmoiditis; radical frontal operation; old	Left frontal lobe	Marked	<i>Streptococcus hemolyticus</i>	Multiple (2) communicating. Small fig and butternut
F. R.	56	M.	Stab wound through old cranial defect	Left fronto-parietal lobes	None	Mixed. Discharging sinus	Elongated hen's egg
J. M.*	12	M.	Mastoiditis with mastoidectomy	Left cerebellar lobe	None	<i>Staphylococcus aureus</i>	Lime
L. A.	32	M.	Frontal sinusitis	Right frontal lobe	None	Specimen lost	Lime

* This patient was operated upon for his abscess by Dr. Daniel S. Cuning, who consulted the author regarding the patient's condition. The plastic procedure was performed by the author.

It is realized that this series of recovered cases is not large, but the fact that 14 out of 17 cases operated upon by this open method lived tends to make one who is accustomed to its use more confident in its efficacy. In fact, one can readily subscribe to the statement by Macewen that "One might almost conclude that in uncomplicated abscess of the brain, operated upon at a fairly early period, recovery ought to be the rule."

Until the probability or likelihood of brain abscess is suspected earlier than has been formerly the case so that diagnosis and localization can be made before a disastrous complication ensues, the mortality rate will continue to be fairly high, regardless of the type of operation used.

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DISCUSSION.—DR. CLAUDE C. COLEMAN (Richmond, Va.).—There has been some unanimity of opinion regarding the treatment of brain abscess. It is generally believed that abscess of the brain does not become operative until encapsulation takes place. In the first stage of abscess formation the condition is a diffuse, septic encephalitis which cannot be drained, and, therefore, attempts at drainage have proved to be harmful, as no effective surgical measures have been devised for the eradication of the infection. One must wait, therefore, for encapsulation before attempting to eradicate the abscess.

While brain abscess is fatal in its tendencies if not operated upon, and while a large majority of patients will die unless the abscess is eradicated, the fact remains that when a patient does die following operation, he generally dies because of the surgeon's well intended efforts to remove the abscess. In other words, fatalities following brain abscess operations are usually the result of spreading the infection into the unprotected brain tissues outside of the capsule.

For a number of years I have used one of the methods to which Doctor King referred. That is, drainage with the eye end of a soft rubber catheter. If there is much difficulty in placing the catheter into the abscess cavity, the fumbling with the catheter is likely to lead to an extravasation of pus outside the capsule and a diffuse encephalitis, with secondary abscess formation. We have been more concerned with and troubled by the small, deeply seated, densely encapsulated brain abscess than any other type of encapsulated abscess. In some cases, particularly deeply seated abscesses, in which the capsule is dense, we have first verified the presence and location of the abscess by means of a ventricular needle over which a cannula is fitted. If the capsule of a deeply seated abscess offers much resistance to the penetration of the ventricular needle, we have slipped the silver cannula into the abscess cavity as soon as the pus began to escape from the needle, and left the cannula for permanent drainage instead of using a catheter. In two of the cases treated by drainage with a soft rubber catheter, the abscess cavity, as determined by the depth of penetration of the catheter, appeared to extend across the median line. This was due to the swelling of the brain on the side of the abscess, with displacement of the falx to the opposite side.

I should like to emphasize what I believe to be a logical attitude toward the treatment of brain abscess; that there is no standardized treatment which will be applicable to all cases. In superficial abscesses with a thin layer of brain tissue between the dura and abscess cavity, I should expect excellent results from Doctor King's "unroofing" operation. In deeply seated densely encapsulated abscesses, one must rely upon simple tapping, as Dandy has advocated, or upon some method of drainage that will empty the abscess with the least disturbance of the surrounding brain. The method of drainage with the eye end of a small, soft rubber catheter or with a cannula fitted over a ventricular needle, for the deeply seated abscess (and many of them are of

this kind), has given about as satisfactory results as any method we have seen reported.

DR. JOSEPH E. J. KING (closing).—As I have stated before, 14 cases out of 17 which were operated upon according to the method described survived, and we have seen an autopsy performed upon only one of these 14. An old man, who was the second in the series of those who survived, and who was an habitual alcoholic, was admitted to Bellevue Hospital three or four years later in an alcoholic stupor, and died. The autopsy revealed no pathologic condition in his brain other than a dilated anterior horn of the right side beneath the site of the operation for a frontal lobe abscess.

None of the cases had epilepsy other than the fourth case who had a traumatic abscess in the right parietal region and who had epileptic attacks before operation.

I agree with Doctor Coleman that if operation can be delayed until a capsule is formed, it is safer than operating in the stage of suppurative encephalitis. In one case of metastatic abscess, which is not included in this series, we were advised by the attending neurologist to operate upon him early, and the patient was fortunate enough to survive. In a previous paper by Doctor Coleman he stated that four out of five deaths were due to leakage about the drainage tube with formation of suppurative encephalitis, which condition resulted in death.

I stated that one would be fortunate to locate a very deep seated abscess and to drain it by any means, but preferably by the small catheter as described by Coleman, or a searcher or cannula, and one would be most fortunate to be able to drain it by any method. I have never advocated the procedure described in this paper for a very deep seated small abscess. The procedure described is intended for abscesses which extend to within 3 or 4 cm. of the surface, exclusive of the basilar surface. Abscesses of this type offer the best opportunity for a successful outcome.

THE SURGICAL TREATMENT OF EPILEPTIFORM SEIZURES

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THOUGH the diagnosis of epilepsy in most of its multiple and varied manifestations is easy, its underlying nervous physiology is obscure and difficult to comprehend. That epilepsy is not a disease is agreed upon. The clinical entity is the result of a sudden, violent discharge of neural elements produced by a noxious stimulus. As Hughlings Jackson expressed it, "an experiment made upon the brain by disease."

There is a form of epilepsy, by some termed "idiopathic" or "true" epilepsy, which has as its only symptom convulsive seizures. No anatomic substratum has ever been discovered for this type of epilepsy. Then there are diseases which have convulsive seizures as a part, and often only a small part, of their symptomatology; for example, intracranial tumors, abscesses, arachnoiditis, cerebral arteriosclerosis and intoxications. Such epileptiform seizures must be differentiated from true epilepsy of unknown etiology. It is with the pathologic conditions accompanied by epileptiform or convulsive seizures that surgical therapy is concerned.

An epileptiform seizure may include symptoms the result of activity of the cortical motor area; the so called sensory area; or the cerebral visual, auditory, olfactory, gustatory, and autonomic centers. In accepting such a conception, there is no difference between a localized motor spasm, paresis of a limb, hallucinations of sound, smell or sight and certain visceral and autonomic phenomena. All are epileptiform seizures, which may usher in a complete convulsive attack, and under such circumstances may be regarded as an aura.

The continued search for the physiologic facts of epilepsy has led to acceptance of the basic unity of the convulsive state as well as to the astonishing variety of stimuli which may produce such episodes. Though the symptoms be protean in character and the nature of the stimulus varied, it is probable that there is a common, connecting neural mechanism.

Since the discovery by Fritsch and Hitzig of the electrical irritability of the brain, numerous theories concerning the site of convulsive discharge have been proposed. It is unfortunate for the clarity of our knowledge that this site has been considered inseparable from the pathogenesis of the seizures. It is further unfortunate that much of the work has been concerned with the establishment of a so called convulsive center.

Three chief theories have been proposed concerning the location of a convulsive site. First, that which deals with the cortex alone; second, that which includes the cortex and subcortex; and third, the medullary theory. The experiments performed to prove any of these theories have been of two

types; first, those in which convulsive seizures have been produced by irritation of various parts of the central nervous system, and second, those in which experimentally produced convulsions have been modified, stopped or prevented by ablation of certain parts of the nervous system.

The proponents of the medullary theory have assumed that if convulsions may be produced by irritation of the pons and medulla, and may occur as the result of intoxication with absinthe in decerebrated animals, the convulsive site either exists in the pons and medulla, or the pons and medulla possess epileptogenous properties. Opposed to this theory are the observations that when a convulsion occurs as the result of irritation of the pons, the clonic element disappears after removal of the cerebral cortex; and that removal of one cerebral hemisphere causes convulsions to disappear from one-half of the body.

Those who support the mixed theory are dependent upon observations of certain motor manifestations produced by stimulation of various parts of the central nervous system and many of these experiments have nothing to do with convulsions. They are concerned with the production of certain forced movements, ataxia and dystonia.

The evidence which has supported the theory of cortical origin has been supplied chiefly by the observation of convulsions produced by electrical stimulation of the cortex. It has been found that convulsions may be produced which resemble epilepsy. It has also been shown that if electrical stimulation of the motor cortex is long continued, the resulting isolated contractions of muscle groups become successive and spread to muscle groups innervated by adjacent cortical areas; then spread to the other side with the resulting convulsion outlasting the electrical stimulation. If an irritated zone be extirpated quickly, the convulsion is inhibited. After deep decortication, such convulsions cannot be produced, and when certain motor areas have been removed the movements represented by such an area are absent in an ensuing convulsion. Not only can such convulsions be produced by irritation of the motor cortex, but by stimulation of other cortical areas such as the occipital lobe.

From our own studies,¹ and from the accumulated reports of experimental work, it may be stated that whatever element of a seizure may be lacking in a convulsion produced in an animal with a mutilated brain, convulsions (tonic, clonic, or both) may be produced from the cortex and subcortical region and, in the latter case, in the absence of the motor cortex. The symptoms of a convulsion vary with the state of preservation of the brain. If it be intact, tonic-clonic convulsions associated with sialorrhea, pupillary changes, bladder contraction, circulatory and respiratory changes, and at times an aura may be present. The aura is dependent upon the area of brain irritated; and in jacksonian attacks, as in artificially produced cortical seizures, motor movements constitute the aura. In other cases, a vagal aura exists, respiratory or circulatory changes precede the convulsion, and the portion of the brain irritated must be that of a lower level. It may be pointed out that

not only is the tonic element of an epileptiform seizure absent in a cortical fit, but loss of consciousness does not occur until a generalized convulsion ensues, and involuntary urination does not occur before the loss of consciousness. A major epileptic convulsion consists not only of tonic and clonic movements, but also of a series of events including the aura, vascular, respiratory, secretory changes, and contraction of the involuntary muscles of the bladder.

The earliest proven adventure of man into the field of major surgery was trepanation for fits, and so it may be said that man's experience with the surgical treatment of the convulsive state began at least a quarter of a million years ago. Though the progress of surgical therapy waxed and waned, the problem of epilepsy has remained persistently for solution. The contribution of Hippocrates to the treatment of injuries of the head gave rise to a literature dealing with the surgical aspects of traumatic convulsions which grew to an enormous proportion by the time of the sixteenth century. To Guy de Chauliac epilepsy was simply a convulsion of the entire body arising from excess of humidity and "it suffices the surgeon to know what has been said of them, their symptoms and cure, if there is any." The character of these surgical procedures may be judged fairly well when it is realized that even during the seventeenth century Thomas Willis struggled valiantly and alone to wean his more philosophic colleagues from an unshaken belief in the rôle of Satan in convulsive states by constantly centering their attention upon the central nervous system.

Our own experience with surgical procedures in convulsive states has been obtained from two types of patients. First, those who have had convulsions produced by intracranial tumors or abscesses, and second, those whose seizures were supposedly the result of trauma to the brain.

In reviewing our material, only cases verified pathologically at operation or by autopsy examination were included. In all but a very few of the cases the pathologic findings rest upon the observations made at operation; in some instances these are supported by an autopsy examination. The remaining cases were studied, though an operation had not been performed, because of a complete description of the pathology found at autopsy. The review of our case records has made it apparent that the material is not so detailed as it might have been had the patients been studied originally with the idea in mind of making a report upon their epileptiform manifestations. For example, we do not have the evidence available nor are we fitted by training or experience to include very important data concerning the so called "epileptic constitution" or "make-up" of our patients. Why do convulsions occur in one patient with an intracranial tumor and not in another patient with a tumor similar in type and location? Similarly, does not the "potentially an epileptic" factor play an important rôle in the development of convulsions in the approximately five patients out of a hundred, all of whom have received severe wounds of the brain?

Obviously, it is not entirely satisfactory to classify the location of the

pathologic changes on the basis of what is observed at operation. Adjacent portions of the brain may be involved in the absence of gross changes in appearance. With proper emphasis upon this reservation, the operative records and sketches, with the exception of those cases in which an autopsy was performed, constitute the basis for localization.

We included in the study of our material all patients with symptoms which to us represented epileptiform manifestations or a convulsive state. Periods of sudden unconsciousness, not syncope; periods of twitching, or drawing of the hand or foot; peculiar odors with periods of apprehension are as significant to us as major seizures; in fact, many of these minor spells are of more localizing and diagnostic value. Many papers in the literature reporting upon the occurrence of convulsions in groups of intracranial neoplasms exclude this important group.

It is exceedingly difficult to obtain an accurate description of a seizure. To describe all its manifestations, if one has the opportunity to observe an attack, is often impossible. Patients are often told what went on after they lost consciousness and many important details of the symptoms are lost. Patients or relatives may regard or neglect minor manifestations as insignificant in the presence of more dramatic symptoms.

Rarely did the seizures occur in a definite period of frequency. However, in spite of the irregularity of occurrence, for comparison they could be grouped roughly into weekly, monthly, or infrequent and single episodes. Postoperatively, the same grouping as to the frequency of attacks was made.

It is in this respect that it is often difficult to compare one case directly with another. It is of more value to compare the condition of the patient before and after operation with and without medical treatment. Is the patient as well off after operation as he was before operation? Can it be said in a given case that the surgical procedure made it impossible to control the convulsions more successfully by adequate bromide or luminal therapy?*

It is somewhat of a surprise to realize the large number of patients with intracranial tumors who have convulsions, and particularly the large number in whom a convulsion was the initial symptom which first called the attention of the patient or his family to his difficulty. It was not long ago that the general impression existed, and it was taught, that the meningiomata were the intracranial tumors most often associated with convulsions. In our own experience, 62 per cent of the patients with glioblastomata; 72 per cent of the patients with astrocytomata; 39 per cent of the patients with meningiomata, and all but one patient of the angioma group presented epileptiform seizures. Four patients of 36 who had pituitary tumors had convulsions, but it should be noted that in each of these patients the tumor had grown outside of the boundaries of the sella turcica. Thirty-seven per cent of our

* By adequate bromide therapy we mean the administration of bromides under careful control of the bromine content of the blood. The variation of the bromine level in the blood necessary to control convulsions in patients has been well established.

patients with metastatic intracranial tumors presented attacks of one type or another.

Neither can the meningiomata be said to be the only group of intracranial tumors which are accompanied by a history of convulsions of long standing. Whereas 58.5 per cent of our meningiomata gave a history of seizures lasting from one to six years or more, likewise the glioblastomata (35 per cent), astrocytomata (57 per cent), and angiomata (75 per cent) presented a history of attacks over an equally long period.

In any series of intracranial tumors, the majority of patients are adults. It is important, therefore, to point out and to reemphasize the fact that convulsions occurring in an adult should be immediately suspected of being due to an intracranial tumor. It remains, therefore, a duty of the physician to bear this in mind and to use every possible diagnostic aid at his command to prove that his patient does not have a space-occupying lesion.

Our records show that although 39 per cent of the meningiomata presented convulsions, choked disks (that symptom which many believe must be present before a diagnosis of an intracranial tumor can be made) were absent in 36 per cent of the patients. Likewise, choked disks were absent in 28 per cent of the astrocytomata; in 17 per cent of the glioblastomata, and in all of the angiomata. Again it should be emphasized that choked disks are a late symptom in a large number of intracranial tumors. We do not mean to state that every adult who has convulsions has an intracranial tumor, but it cannot be repeated too often that to prove that the patient does not have an intracranial tumor is the duty of the physician and not the individual.

Intracranial abscesses may be considered in the same group as the intracranial tumors in relation to the occurrence of epileptic manifestations. Of our 42 patients in the abscess group, 15 had convulsions. Of these 15, five are still living and three of these five still have convulsive seizures which must be controlled by bromide therapy. Twelve of the 42 patients are still living and none of these 12 had seizures after operation who did not have them in the acute stage of their illness before operation. The period of time during which seizures were present before operation was very definitely shorter than that found in the intracranial tumor cases and this can easily be explained by the more acute nature of the pathology present.

Our material was studied to determine whether or not any relation existed between the occurrence of epileptiform seizures and the location of the tumor or abscess. Quite in keeping with what our general ideas have been from our clinical experiences and experimental investigations, we found that seizures occurred in patients with tumors which were situated in the cortex, subcortex, pons, midbrain, third ventricle, and posterior fossa. The only tumors which occur in the posterior fossa and which were not accompanied by convulsive seizures in the patients in our series were the acoustic neurinomata.

An attempt was also made to relate certain epileptic manifestations with definite functional areas in the brain. It should be immediately recognized

that this is just as difficult as it is to draw conclusions concerning cerebral localization from tumor or abscess pathologic material. Both at operation and autopsy it is hard, particularly in the gliomata, to determine the limits of the tumor growth. Although a meningioma does not involve the brain directly, the extent of damage produced by pressure is equally as difficult to determine. So, we have been able only to make certain rather general deductions in relation to gross divisions of the brain. After analyzing all of the cases for objective and subjective phenomena presented in the described seizures, a very few facts stand out. For example, as compared to the frontal, temporal and the occipital lobes, localized muscular twitchings, commonly described as a jacksonian attack, occurred by far more often in these tumors situated in the parietal lobe. On the contrary, when such objective symptoms as pallor, drooling, cyanosis, flushing, or lacrimation occur, all of which might be grouped as vasomotor phenomena, they were found to be present in tumors in the frontal or temporal lobes and not in tumors of the parietal or occipital lobes. Loss of consciousness occurred just as often in the tumors of one lobe as of another. We cannot subscribe completely, therefore, to the view that arrest of consciousness occurs when the frontal lobe alone is discharging.

Likewise, it is obvious from our material that the subjective epileptic manifestation of a bad odor or taste occurred exclusively in tumors of the temporal lobe and, more particularly, in tumors which involved the medial aspect of that lobe, the uncinate gyrus. The subjective symptom crudely described by the patient as "tingling, numbness, or electric shock" occurred more often in parietal lobe tumors situated within or posterior to the postcentral convolution; but in two instances of frontal lobe and in the same number of temporal lobe tumors, the patient described a similar sensation preceding his attack. Here, of course, lies the danger of stating that this symptom occurs in temporal or frontal lobe tumors, because only by careful pathologic examination of the entire brain could one be justified in stating that the postcentral convolution of the parietal lobe was not involved by the tumor. Such a circumstance could also be explained, of course, by an involvement of one of the large cerebral arteries so that an epileptiform seizure might begin in any portion of the brain at a distance from the neoplasm but in the area of distribution of the artery. We have found it to be true in every instance that the patient who had a visual aura had a tumor in the occipital lobe. The exception to this has been those patients with tumors in the temporal lobe whose aura was one involving objects rather than light or color. We have seen temporary complete blindness during the discharge of the occipital lobe produced by a tumor, and this has been demonstrated by others.

Penfield² has reported the occurrence of "autonomic epilepsy" which occurred in a patient with a tumor of the third ventricle. It would seem from this case that a convulsive discharge may occur from centers as high as the anterior portions of the thalamus. The reports of other patients with sensory

epileptiform seizures in which the tingling spread gradually through one side of the body and became so severe as to be painful also suggests that the gray matter of the thalamus may become involved even if the original discharge does not take place there.

It has been our experience that immediately preceding a convulsive seizure, deviation of the head and eyes occurs toward the side of the lesion, that is, toward the site of irritation. This is not in accord with statements of some individuals who feel that the most frequent lateralizing sign is deviation of the head and eyes to the side opposite the hemisphere involved. It is important to attempt to localize epileptic manifestations within the brain so that convulsive seizures can be accurately interpreted, as an aid both to diagnosis and therapeutics, but we doubt very much whether or not definite epileptiform manifestations can be ascribed solely and specifically to certain lobes or gyri of the brain. However, we are able to confirm the clinical fact which has been known for some time that the epileptic manifestations of a tumor in the posterior fossa are very definite. They have been described previously as "cerebellar fits." The outstanding characteristic of these convulsive states is the occurrence of a tonic convulsion involving all four extremities, opisthotonos, with marked respiratory and vasomotor symptoms. Convulsions have occurred in eight patients with posterior fossa tumors. Three of these were children who had medulloblastomata.

When one begins to determine the effect of removal of an intracranial tumor upon the occurrence of convulsive attacks, several factors arise which interfere with the collection of data of accurate scientific value. It is not always possible to determine the frequency or the nature of seizures in a given patient before operation under the conditions of accurately controlled bromide or luminal therapy, or without therapy. Likewise, it is not always possible after operation to allow a patient to go for a period untreated with medicine in order to make a comparison with his condition under treatment. It is very seldom that the patient with epileptiform seizures is observed over a sufficiently long period before operation by the surgeon who removes his intracranial tumor. This introduces the factor of the judgment of several clinicians as to severity, frequency, and nature of the attacks before and after operation.

We have attempted to study all of our intracranial tumor patients in an effort to determine whether the attacks were more frequent after operation; whether they remained the same; whether they were less in frequency; or whether they did not recur. As was stated, these figures can be taken only in a general way and represent patients who were not given bromide or luminal therapy after operation. Of the patients with glioblastomata, and it must be remembered that the life expectancy of patients with this type of tumor after operation is on the average of 6 to 18 months, 10 per cent of those having attacks prior to operation had none after operation up until the time of death, and 32 per cent had fewer and less severe attacks following operation. Of the astrocytoma group, 31 per cent were judged to be unim-

proved as far as their convulsions were concerned. Fifty per cent had fewer and less severe attacks and 6 per cent had no attacks following operation over an interval of 3 and 6 years, respectively. These figures represent about the condition which exists in the other tumors in the glioma group.

Of the meningioma group, and in these patients the tumor was removed completely, three patients were definitely worse following operation and finally had to be placed on bromide or luminal therapy. Eight patients had fewer attacks which were less severe, but were not entirely free, in spite of the fact that their tumors had been completely removed. The remaining five of the 16 patients in the group who had convulsions before operation had no further convulsions following removal of their tumor and have been without bromide or luminal therapy. It becomes apparent that although these tumors have been removed completely certain changes must have been produced within the brain which continue to act as irritative foci which release a convulsive discharge. These changes may be and probably are microscopic in nature and further surgery under such circumstances is illogical and contraindicated. Particularly is this true when these attacks can be so well controlled by judicious medicinal therapy.

In general, one may say without a doubt that the removal of an intracranial tumor is followed in the majority of patients by definite improvement in the frequency and severity of the convulsive seizures. It cannot be guaranteed, however, that the attacks will completely disappear. It is now our custom to begin bromide or luminal therapy preoperatively upon those patients who give a history of convulsive attacks and to continue that therapy after operation. By maintaining a constant bromine level in the blood the patient's attacks can be stopped and gradually the dosage of bromides be reduced.

As our records show, successful drainage of a brain abscess may be followed in later years by the development of epileptic seizures and the pathologic changes which occur in the brain during the obliteration of the abscess cavity provide a focus from which the convulsive discharge may occur.

A second group of patients with convulsive seizures are those in whom trauma to the brain has played an important rôle. Here again, before the exact rôle of trauma can be evaluated in each case a study should be made to determine what part the constitutional makeup of the individual has played in the development of the epilepsy. This is particularly emphasized by the statistics which have been gathered by a number of men relating to the occurrence of epileptiform attacks following trauma to the brain. In a group of 18,000 cases of gunshot wounds of the head, Turner finds that less than 5 per cent of the patients developed seizures. The statistics vary above and below that figure and, of course, it must be realized that the cases studied are not directly comparable. The material, no less than the observers, varies so greatly that it is difficult to find a common basis for reckoning the percentage of instances. However, 5 per cent may be taken as a reasonable percentage of the occurrence of convulsions after trauma to the brain.

Granted that the character and severity of trauma in the group of cases is comparable, how is one to explain the fact that the remaining 95 per cent of patients never develop epileptic seizures?

It has been well established that when the brain is injured and the damaged cerebral tissue is not removed, a scar of fibrous astrocytes, connective tissue and newly formed vessels develops. This scar soon becomes densely adherent to the overlying meninges. The rich plexus of blood vessels anastomose with the cerebral vessels on one side and with the vessels of the meninges and scalp on the other. Like all cicatricial tissue, this scar contracts and a pull upon the framework of glial and vascular tissue develops. This cicatricial pull is not confined to the local area of scar tissue; the homolateral hemisphere and even the entire brain is affected.

Foerster³ has described the mechanism of the pull of such a cicatrix. He noted a displacement of both lateral and third ventricles toward the site of the scar tissue with enlargement of the lateral ventricle upon the side of the lesion. There is a certain amount of cerebral atrophy which accompanies the formation of scar tissue, but it probably plays no important rôle in the ventricular displacement.

Penfield's⁴ examination of the scar tissue removed invariably showed fibrous tissue near the surface of the cortex and meningeal adhesions. The fibers of astrocytes were arranged parallel to the direction of traction and extended upward toward the scar. Deep within the brain the astrocytes and blood vessels formed the only framework capable of resisting the constant pull of the contracting cicatrix. In cases of long standing, tubes and shoots of neuroglia surrounded by connective tissue sheaths may result from the progressive cicatrization. We have seen gelatinous, yellowish-gray fibrous tissue as the center of an area of atrophy and cyst formation in old cases; a fact which Foerster and Penfield⁴ record, emphasizing the focus of concentric traction.

The pathogenic relation between the formation of the scar, the development of a vascular plexus, the steady pull of the contracting scar and epileptic attacks are immediately suggested. Foerster and Penfield have expressed the problem very clearly: "If the stimulus for an epileptic seizure arises in the nervous elements one might expect the attack to begin shortly after the infliction of the wound when these elements are plentiful and undergoing progressive destruction . . . If, on the other hand, the vascular elements are responsible for the initiation of the process, epilepsy might well be expected to make its appearance later, when the vascular plexus reaches its fullest development and nerve fibers have largely vanished.

"It has been shown that at operation the focal epileptic attacks may often be produced in two ways: either by electrical stimulation of the brain in the neighborhood of the wound, or by gently pulling upon the adherent dura. This latter fact may be of considerable significance, for, if the increase of a pre-existing strain produces an attack, it may well be that the

pre-existing strain itself is an important factor in the etiology of spontaneous convulsions.

"As pointed out above, the blood-vessels form in one sense the roof of the contracting network. Traction, therefore, upon the vessels must be inevitable. The hypothesis at once suggests itself that a vasomotor reflex secondary to this traction is responsible for the initiation of the convulsive seizures."

The radical excision of one of these extensive, contracting scars for the relief of convulsions, assuming that the mechanism just described constitutes the pathogenesis of the attacks, can be a rational procedure only if the damage produced by excision is not accompanied by the same train of histologic events that followed the original lesion. Penfield's⁵ histologic studies made upon the excision of cerebral tissue would point to an entirely different result. He has stated that when brain tissue is excised, there is no organization of connective tissue. Instead, a fluid-filled space with a small amount of gliosis about it appears. There is no plexus of newly formed vessels and there is no evidence of a cicatricial pull upon the surrounding brain tissue. Brain injury and brain excision are followed by entirely different structural changes.

If this were the entire story underlying the surgical relief of epileptiform seizures, the problem would be relatively simple. Only the careful study of patients, as human experimental problems, will answer the question of the wisdom of substituting a non-contracting fluid-filled space for a contracting cicatrix. One must assume, in such a working hypothesis, that removal of an apparently gross area of irritation will cause the entire neural mechanism responsible for a convulsion to disappear. This question has not been answered as yet by clinical cases carefully studied over a sufficiently long period. However, a valuable suggestion for the prophylactic treatment of severe brain and skull injuries has been made. The careful painstaking débridement of compounded craniocerebral injuries might reasonably be expected to decrease the incidence of posttraumatic convulsive attacks.

Our experiences with posttraumatic seizures have been purposely limited to those individuals who have organic evidences of the severity of their original injury; those who have organic symptoms following their convulsions and those in whom encephalographic studies demonstrate a mechanical defect which surgical intervention may be expected to remedy. This means that we have never attempted to localize the site of a suspected focus by an interpretation of the pattern of the attack alone, and then subsequently excise that area of cortical tissue. The physiologic interpretation of our own experiments on convulsions as well as our clinical observations lead us to believe that in the present state of our knowledge such a procedure is unjustified.

The material includes 13 patients whose attacks were attributed to craniocerebral compounded wounds due to blows on the head by bricks, pipes, hammers; bullet wounds, or automobile injuries; four patients with perencephalic cavities some of which were associated with a congenital skull defect;

one patient with a definite history of birth injury; and five patients with convulsions which followed encephalitis, all of whom had focal attacks with organic symptoms of the lesion.

In contrast to the 13 patients with severe compounded craniocerebral wounds with convulsions, we have observed and treated 32 other patients all of whom had gross cerebral damage, and none of whom has as yet developed convulsive seizures. However, this time limit apparently never runs out. Six of the 13 patients had an interval of over six years between the injury and their first attack. The longest interval was 21 years and the shortest six months.

Apparently the site of injury and the length of the period of coma have no bearing upon the subsequent course of events. Five of our severely injured patients had no loss of consciousness; three were in coma a few hours and five were unconscious for from 12 hours to a month. The site of injury was equally distributed between the frontal, parietal, temporal, and occipital areas of the skull.

The convulsive attacks in this group of 13 patients were predominantly major in character in eight instances. That is to say, the attacks began as focal seizures, then became generalized and were accompanied by loss of consciousness. In the remaining five patients, the attacks were characterized by momentary dreamy states or localized muscular twitchings. The frequency of attacks varied from several each day to one every six months. Two patients had repeated attacks and then without any apparent reason had intervals of as long as six and ten years without an attack, only to develop a status epilepticus.

At operation several varieties of pathologic changes were observed in this group of cases. In all of those in which there had been gross damage to the scalp, skull and brain, dense adhesions were found between the dura mater, brain and skull. In several instances the skull defect had caused the underlying brain to become firmly attached to the scalp. As the scalp flap was elevated, the scar tissue pull would bring the brain along with it. We found all grades of arachnoidal thickening, often so opaque that the cerebrospinal fluid accumulated in lakes along the sulci between the convolutions. Often the fluid so trapped was yellow in color, further evidence of the lack of circulation in the subarachnoid space.

Increased vascularity of the dura mater and cicatrized brain tissue was a constant finding. In one patient, who had received a stellate-shaped depressed fracture of the temporal bone 21 years before her first attack, large arteries and veins formed suspension cables in some areas between the cortex and dura mater. Associated with these more or less external changes, we invariably have found an area of cortical cicatrization, thick, firm, grayish-yellow in color and easily recognizable in differentiation from the normal brain tissue. Often the center of this cone shaped tissue was soft, gelatinous and cystic.

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injury as a boy and who had his first convulsive seizure eight years later. After an interval of another 13 years during which convulsions occurred at irregular intervals, he developed weakness in the right face, arm and leg and presented himself for treatment. At operation the cortical scar was blocked out and removed en masse. In spite of a period of freedom from attacks for eight months, the convulsions returned. He was placed on carefully controlled therapy but died in status epilepticus. The appearance of the brain after surgical removal of the originally damaged tissue approximates very closely the condition found at operation except for the smaller size of the scar.

In two cases we removed a foreign body in the center of the fibrotic tissue; in one instance a screw and in another a bullet, with complete relief of the seizures. In two patients, rib transplantation was performed to prevent recurrence of the adhesion between the scalp and dura mater. One of these latter patients is now free from convulsions though it is necessary for him to take 30 grains of bromides daily in order to keep his blood bromine content at 125 mg., which for him is the nonconvulsant level. In one instance we removed a large calcified mass from within the cortex which had evidently developed from an area of hemorrhage, and the patient has had no more attacks though he has never received bromides.

In evaluating the results following operation we find that there was no improvement in one patient; another died in status epilepticus after an eight months' period of freedom; another patient has had no attacks in nine years, though it must be noted that there was a free interval of six years before operation. In one patient the character of the attacks has changed. For six years he has had no major convulsive attacks but "dreamy states" occur about once every six to eight weeks. Other patients have been free from attacks for a year or less without medication.

Our results in those patients with large cortical defects, following injury at birth or accompanied by congenital defects in the skull, have been equivocal. The most satisfactory experience occurred in a boy of ten who had a left hemiparesis and homonymous hemianopsia. His jacksonian convulsions had been present since his birth by a prolonged, instrumental delivery. A ventriculographic study showed an enormous, somewhat localized dilatation of the body of the right lateral cerebral ventricle. The roof of this portion of the ventricle consisted of a thin, vascular, transparent, gelatinous structure. When it was opened the markedly hypertrophied choroid plexus floated. The choroid plexus was removed from the lateral ventricle and only the dura mater remained to cover the cortical defect. Surprisingly, the hemiparesis disappeared and for six years he has had no attacks.

In contrast are the remaining four patients in this group, all of whom had a localized area of cystic degeneration of the cortex and in three of whom there were overlying defects in the skull. Resection of the area of obvious gross pathologic change has in no way modified the course of the convulsive seizures. In each of these patients encephalographic studies

clearly demonstrated the mechanical defect in the ventricular system and subarachnoid spaces.

There remain five patients, all of whom had localized jacksonian attacks, with definite motor weakness and reflex changes following their convulsions. None of these patients gave a history of trauma at or following birth and there were no evidences of congenital defects, but in each there was a clear history of an infectious illness followed by the apparent residue of an acute or subacute encephalitis.

Here again the dubious character of the clinical results of operative interference is obvious. In one patient whose right-sided convulsions began at the age of 13, in whom evidences of paresis were present and who was in a status epilepticus, surgical exposure of the brain revealed generalized increase in the cortical vascularity and evident thickening of the arachnoid. The operation was followed by an entire freedom from seizures for seven years. It is difficult to attribute such a clinical result to a surgical procedure which amounted only to inspection of the brain. It is still harder to explain why the patient has recently had a recurrence of similar attacks.

In three other patients with a similar clinical story and with almost identical findings at operation, no such false hopes of a cure were raised. Their attacks continued unchanged in frequency or character in comparison with their preoperative condition.

In contrast, the remaining patient in this group presented encephalographic evidence of a dilated ventricle, its roof pulled toward the scarred and gliotic cortex, which had the consistency of a piece of gristle. One might justifiably believe that resection of this area, with demonstrable return of the ventricular system to the midline, would be followed by improvement, but such was not the case. Within a year the ventricular roof and lateral wall were again pulled outward by a contracting cicatrix, and at no time were the convulsions materially altered.

The recitation of these experiences in the surgical treatment of epileptiform seizures emphasizes to us the striking complexity of the entire mechanism of the convulsive disorders, and we have dealt only with those patients who have shown some concrete evidence that they might be benefitted by a surgical procedure. It is obvious that at least one factor, as yet ill-defined and comparatively unknown, must play an important rôle in the determination of successful results and failures. This factor of the so called "epileptic constitution" must be studied in these patients in whom surgical indications appear more or less definite, but first there must be agreement upon just what such a term implies.

Like some other fields in neurologic surgery this problem remains for solution. It cannot be dismissed as being completely unfruitful, but neither should operations be undertaken except under conditions which approximate those of the experimental physiologic laboratory as closely as is possible. Certain it is that freedom from attacks in patients three, five or even seven years after operation cannot be presented as evidence of the complete cure

of their attacks, but the accumulation of accurately reported data may eventually lead to the establishment of surgical indications and may provide a valuable link in the solution of an intricate neurologic problem ages old.

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CARCINOMA OF THE BREAST

A STUDY OF THE FIVE YEAR END-RESULTS

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THE subject of carcinoma of the breast has been so recently, thoroughly and adequately presented before this association by our late Fellow, Dr. Burton Lee, in 1932, and by our former president, Doctor Trout, in 1933, that no attempt will be made here to present an exhaustive treatise on the subject. This will be merely a presentation of certain facts and figures obtained from the observation and study of such cases occurring at Steiner Clinic from the time of its inception in September, 1924, to July, 1930. During these first years the material available was naturally much less than it is today, and the histories were frequently inadequate, making a complete study impossible.

During the period under consideration, 261 cases of carcinoma of the breast were admitted for treatment. Many of these had been operated upon elsewhere, and had recurrences, or were too far advanced to receive anything but palliative treatment.

We used the standard of operability laid down by Lee, namely, "A case is '*operable*' when a patient has a tumor of the breast that is not fixed to the chest wall, with or without invasion of the axillary lymph nodes. . . . If there are wide multiple cutaneous nodules around the original tumor site, if there is a swollen or painful arm with extensive axillary metastases, if the supraclavicular nodes are invaded, or if there are distant metastases to the chest or bones, the case should be considered '*inoperable*' . . ." Lee finished the sentence . . . "and radical operation should be withheld." We are not in accord with this last statement, and in a previous paper before this association one of us endeavored to show that frequently a radical operation, performed as a palliative procedure, would leave the patient more comfortable than she would have been without it. Some apparently hopeless cases have lived in comfort for many years. We feel that the primary standard of operability should be used merely in statistical studies, so that a fair comparison can be drawn between various series of cases and end-results evaluated. Many of the cases which are not primarily operable should be given the benefit of a radical surgical procedure. Consideration of one's personal statistics and records should never jeopardize the best interests of the patient. Employing the above standard, there were 74 "*operable*" cases.

First Symptoms in Cancer of the Breast.—As previously mentioned, complete data were frequently not available. Many cases had been operated upon elsewhere; in many, the records were incomplete and in others the patient had been "lost" from our follow up. In the following observations the number of cases comprising each group is noted; all cases in which the data were available were included. There was no selection. The first symptom occurring in 238 cases is detailed in Table I.

TABLE I
THE FIRST SYMPTOMS NOTED IN 238 CASES

First Symptom	All Cases		Primarily Operable		5 Yr. Cures. All Cases		5 Yr. Cures. Prim. Op.	
	%	No.	%	No.	%	No.	%	No.
Lump.....	75.21	179	26.25	47	8.38	15	31.91	15
Pain.....	8.	19	31.6	6	10.52	2	33.33	2
Lump in axilla.....	2.52	6	50.	3	16.67	1	33.33	1
Tenderness of, or Itching about nipple.....	2.52	6	50.	3	33.33	2	66.67	2
Ulceration of, or crust over nipple.....	2.10	5	60.	3	20.	1	33.33	1
Enlargement of breast.	2.10	5	20.	1	0	0	0	0
Bleeding from nipple (lump?).....	1.68	4	50.	2	50.	2	100.	2
Red area, or tender lump, or red nodule.	1.68	4	75.	3	0	0	0	0
Burning or stinging sensation in breast..	1.68	4	25.	1	25.	1	100.	1
Lump in supraclavicular region.....	.84	2	0	0	0	0	0	0
Wrinkle under breast..	.42	1	100.	1	0	0	0	0
Sinking in of breast...	.42	1	100.	1	0	0	0	0
Pain in lower back....	.42	1	0	0	0	0	0	0
Swelling of arm.....	.42	1	0	0	0	0	0	0

These coincide strikingly with the figures given by Lee from an analysis of 1,000 breast malignancies. Consideration of the percentage of cases which were primarily operable, as well as the five year results as shown in Table I, bear out Lee's further observation that certain symptoms are more unfavorable than others and that these are doomed from the outset.

In our series the operations were performed by a number of surgeons, but in most cases were by one of our staff. As a general rule, a definite routine was carried out, namely, a preoperative cycle of high voltage roentgen therapy treatments, a suberythema dose being administered through four or five ports, followed by a radical mastectomy in from ten days to three weeks after the last treatment. A postoperative cycle was given 60 days after the preoperative treatments, and in the case of a radiation sensitive tumor, a second postoperative cycle was given two to three months later.

CARCINOMA OF THE BREAST

Subsequent radiation, either from radium or roentgen ray, was used where indicated in the individual case.

Occurrence by Age Groups.—The following table shows the occurrence of cases (based on 261 cases) by age groups (Table II), (Charts 1, 2, 3 and 4).

TABLE II
OCCURRENCE BY AGE GROUPS IN 262 CASES

Age	All Cases	Primarily Operable		5 Yr. Cures. All Cases		5 Yr. Cures. Prim. Op.	
		No.	%	No.	%	No.	%
26-30.....	5	1	20	1	20	1	100
31-35.....	8	4	50	1	12.5	1	25
36-40.....	31	9	29	3	9.6	3	33.33
41-45.....	38	11	23.7	6	15.8	6	55.55
46-50.....	36	10	27.77	1	2.74	1	10
51-55.....	43	17	40	6	11.6	6	35.35
56-60.....	36	8	22.22	3	8.33	3	37.50
61-65.....	21	9	42.85	5	23.8	5	55.55
66-70.....	17	5	29.3	3	17.6	3	60
71-75.....	9	2	22.22	0	0	0	0
76-80.....	7	0	0	0	0	0	0
81-85.....	1	0	0	0	0	0	0

PERCENTAGE OF PRIMARY OPERABILITY BY AGE GROUPS

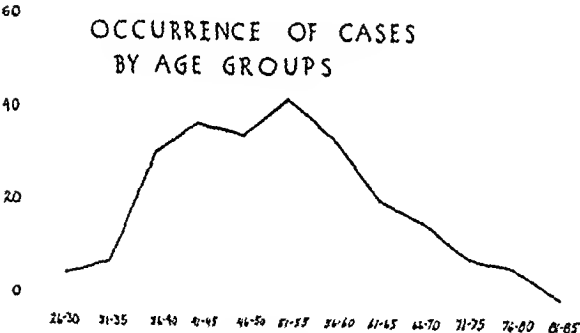


CHART 1.

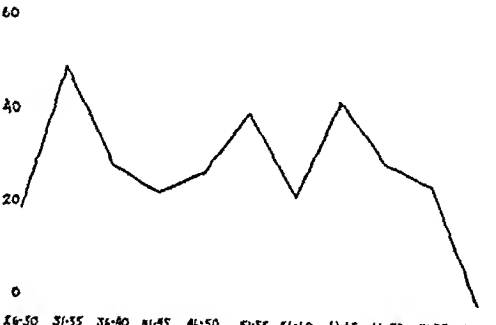


CHART 2.

It will be noted that the greatest number of cases occurred between 41 and 60, and of any five year period from 51-55. It is rather surprising to find such a high percentage of five year cures in the youngest group (Charts 3 and 4), but attention is called to the fact that there was only one primarily operable case in the 26-30 group, and that one happened to be free of symptoms at the end of five years. After that the percentage is below the series average until the 41-45 group is reached. Then there is an unexplainable drop to 10 per cent between 46-50. The percentage of cases which were primarily operable runs about as would have been expected, except for the unexplainable drop in the 56-60 group.

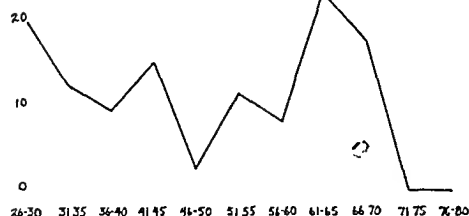
PERCENTAGE OF FIVE YEAR CURES
(ALL CASES) BY AGE GROUPS

CHART 3.

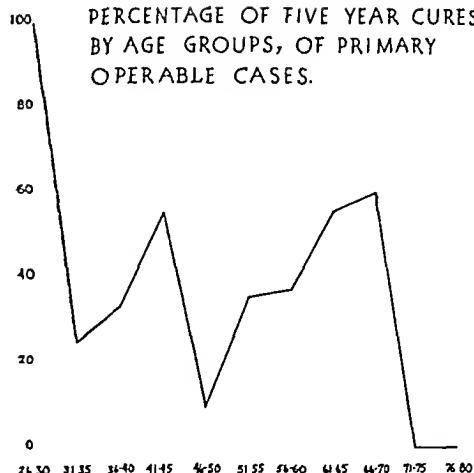
PERCENTAGE OF FIVE YEAR CURES
BY AGE GROUPS, OF PRIMARY
OPERABLE CASES.

CHART 4.

Sex.—In the primarily operable group, there was no case in a man, and but one male case in the whole series. This is a smaller incidence than is generally found.

TABLE III
MARITAL STATE

	Percentage	Percentage Primarily Operable	% 5 Yr. Cures
Single.....	14	31.4	11.11
Widowed.....	36.4	29.6	14.2
Married.....	49.6	33	13.7

Marital State.—Table III, and Chart 5, show the marital state, the primary operability in each, as well as the five year cures. The primary operability is practically constant, but in the single persons there was a smaller percentage of five year cures.

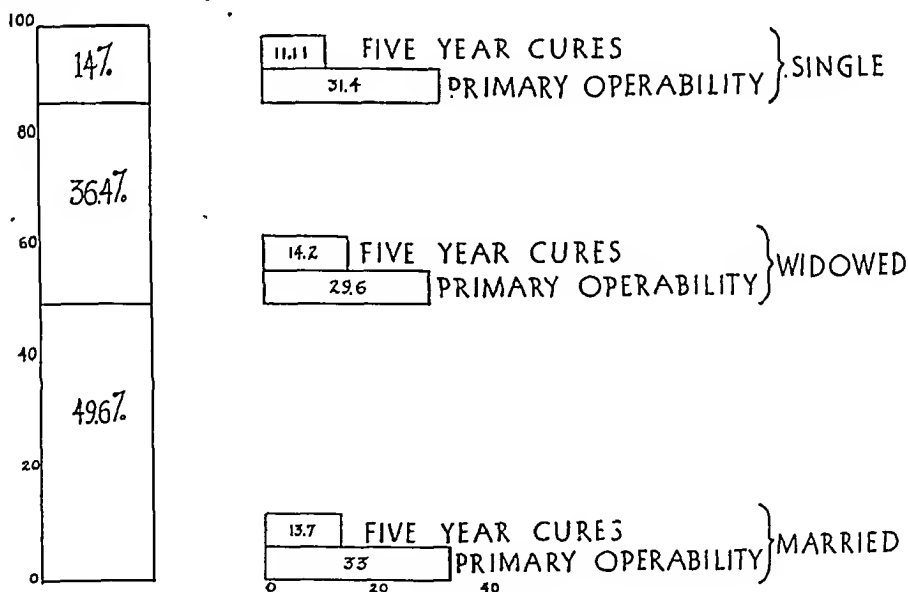


CHART 5.

CARCINOMA OF THE BREAST

Effect of Pregnancies.—Table IV, and Chart 6, show the division of cases according to the number of lactations (205 cases).

TABLE IV
EFFECT OF LACTATIONS IN 205 CASES

Number of Lactations	% of Cases	Primarily Operable		5 Yr. Cures. All Cases		5 Yr. Cures. Prim. Op.	
		No.	%	No.	%	No.	%
0	30	17	28.8	7	11.86	7	41.2
1	14	10	35.7	3	10.7	10	30
2	13.5	11	40.74	7	26	7	63.63
3	16.5	10	30.30	7	21.21	7	70
4	8.5	4	23.5	2	12	2	50
5	6	5	41.66	2	16.66	2	40
6	5	4	44.44	2	22.22	2	50
7	1.5	0	0	0	0	0	0
8	2	1	25	1	25	1	100
9	2.5	3	60	1	20	1	33.33
10	2	0	0	0	0	0	0
11	0.5	1	100	1	100	1	100

Note that no case had seven lactations—and such a small percentage had more than seven that the oscillation of the graph in the upper numbers is not reliable. A larger percentage of cases occurred in the nulliparous breast than in any one group, but there were over three times as many in those which had lactated. The primary operability seems to increase with two or

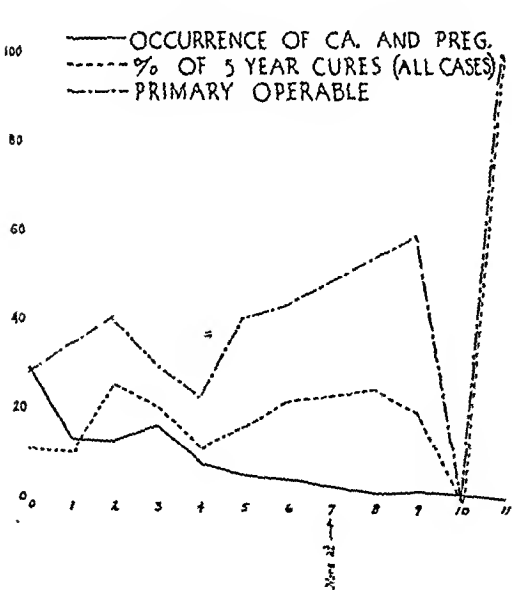


CHART 6.

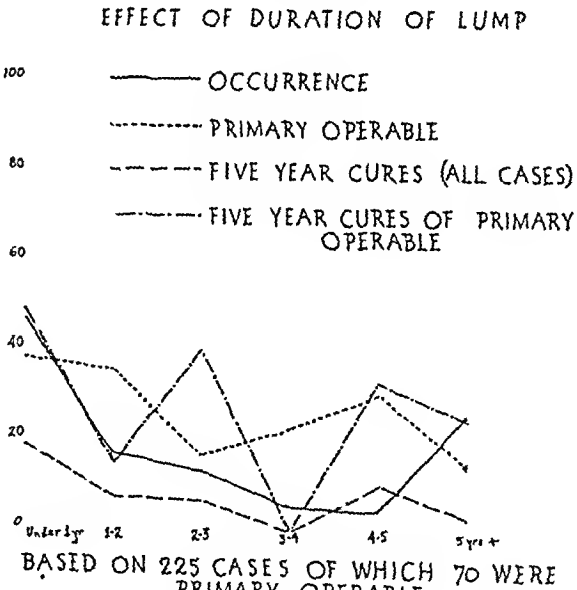


CHART 7.

more pregnancies, as well as the percentage of five year cures. From this it might well be deduced that when a breast has performed the function for which it was intended there is less chance of a carcinoma being inoperable and a greater chance of cure. It logically follows that if for any reason a

lactation is interrupted, the breast should be adequately and persistently emptied with a breast pump. At each ovulation the breast undergoes a change in preparation for lactation. Following failure of the ovum to be fertilized, the breast should theoretically return to normal, but practically this does not always take place. Bagg and Adair showed that carcinomata could be produced in rats' breasts by merely blocking the ducts and allowing the animal to continue to breed.

Effect of Duration of the Disease.—Based upon 225 cases in which information is available, Table V, and Chart 7 present the effect of the duration of the disease. All cases in which the disease has been present for more than five years before admission have been grouped together. Otherwise, they are classified by years.

TABLE V
EFFECT OF DURATION OF DISEASE IN 225 CASES

Duration of Disease	% of Cases	Primarily Operable		5 Yr. Cures. All Cases		5 Yr. Cures. Prim. Op.	
		No.	%	No.	%	No.	%
Less 1 yr.	47.15	41	38.31	20	18.69	20	48.78
1-2 yrs.	17.55	14	36	3	7.7	3	14.3
2-3 yrs.	13.33	5	16.67	2	6.67	2	40
3-4 yrs.	5.78	3	23	0	0	0	0
4-5 yrs.	4.44	3	30	1	10	1	33.33
Over 5 yrs.	11.55	4	15.4	1	3.8	1	25

The primary operability decreases until the disease has existed longer than three years, and then shows a progressive increase for two years. Could this be due to the probably low malignancy of any growth which would persist longer than three years?

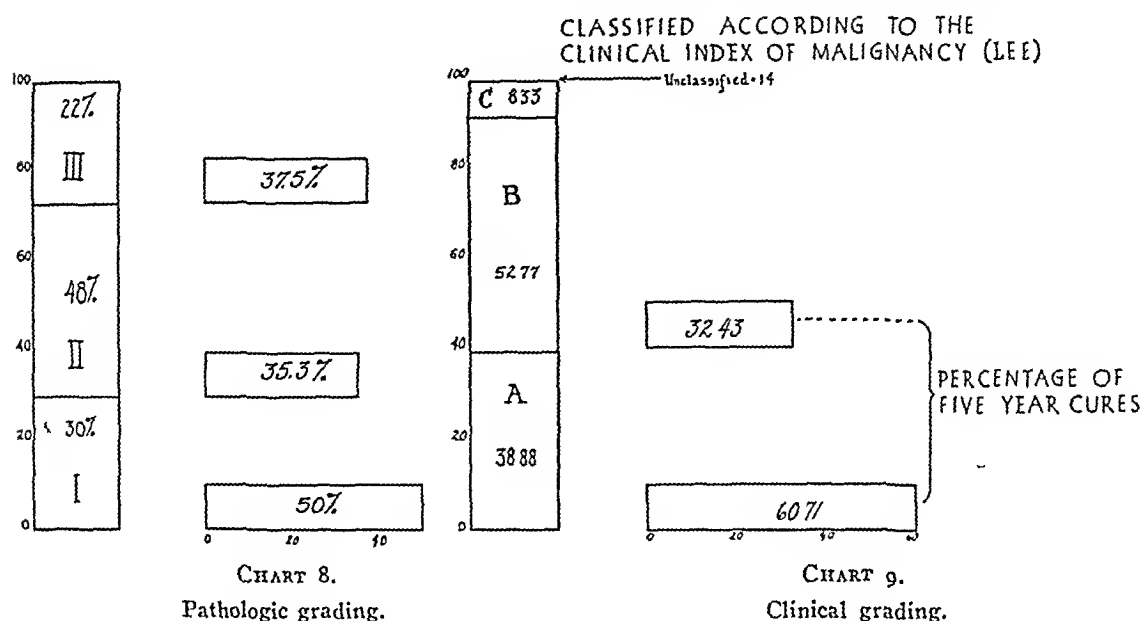
Clinical Versus Pathologic Grading as an Aid in Prognosis.—Trout quotes many authorities and proves rather conclusively that a classification based on clinical evidence is of more value from a standpoint of prognosis than is one graded histologically without any consideration or knowledge of the clinical history.

In the present series the tumors had not, as a rule, been graded pathologically. The names and numbers of the primarily operable patients were given to our pathologist, Dr. Everett L. Bishop, and he was asked to grade the slides histologically, without any knowledge of the clinical histories (Chart 8).

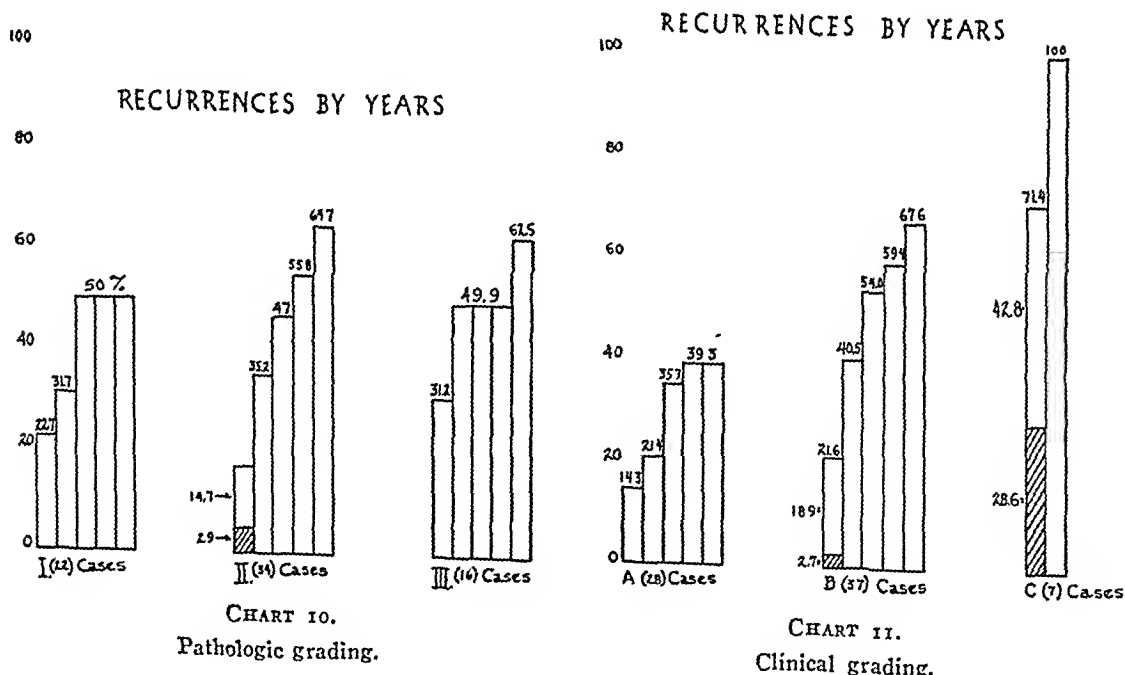
The same cases were graded clinically according to the Clinical Index of Malignancy (Lee) (Chart 9).

It is interesting to note that the percentage of cases occurring in the corresponding grades is strikingly similar, but in the histologic grades the

five year cures are not reduced as much as one would expect in the Grade III cases. It has been suggested that this might be because these tumors are more sensitive to radiation. This does not explain so great a disparity.



Neither system is infallible. There were notable exceptions in each. For example, one case graded A and III is living without evidence of disease over nine years, while another graded A and I died from her cancer in nine months. In at least 11 cases, of which the above two represent the extremes, either one or both systems of prognostication failed utterly. In most cases, however, in our series, one is justified in feeling that the Clinical Index of Malignancy gives a reliable indication of the probable outcome, and is more dependable than a pure histologic classification. The pathologist, as one member of the "cancer team," should have sufficient clinical data to allow him to more accurately grade the tumor.



DEATHS BY YEARS

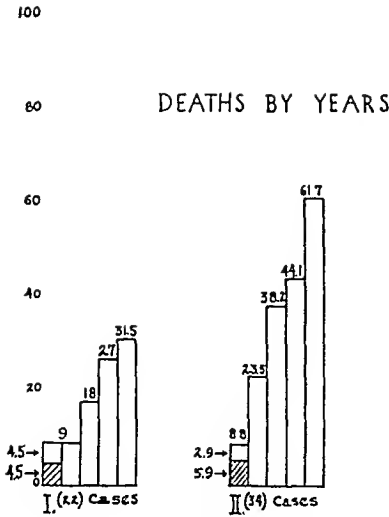


CHART 12.

Pathologic grading.

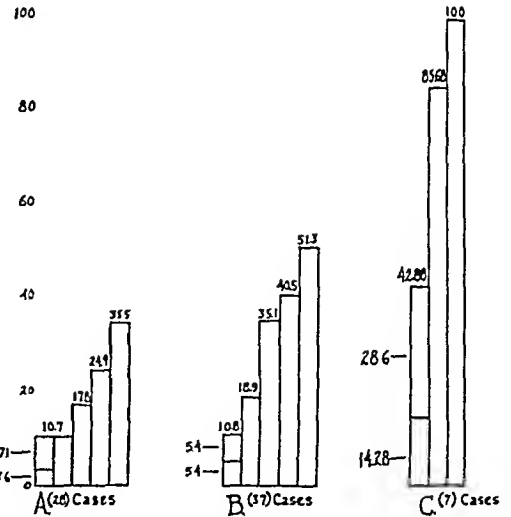


CHART 13.

Clinical grading.

Location of Tumors in the Breast.—In the 61 cases of the primary operable group in which the location of the tumor was stated, and in which the whole breast was not involved, we find 54.10 per cent of the cases occurring in the left breast. Chart 14 indicates the percentage of cases occurring in each part of the breast, and Chart 15 the five year cures by locations. The latter is based on too small a number of cases in each location to justify many definite conclusions, but the overwhelming preponderance of the tumors in the upper half of the breast is certainly significant. Why should so many more tumors occur in the upper portion of the breast? Could it not be explained by the imperfect lymphatic and other drainage from the upper portion of the gland, due in turn to the poor support, natural or artificial, of the breast? Is this another penalty exacted because we now walk on two legs? Trout refers to the absence of carcinoma in the udder of the cow, and ascribes this to her frequent and continuous use of the breast for its physiologic purpose. Might not the lowly cow, in spite of the frequent lactations, experience a malignancy in her organ of lactation more frequently if she

OCCURRENCE BY QUADRANTS

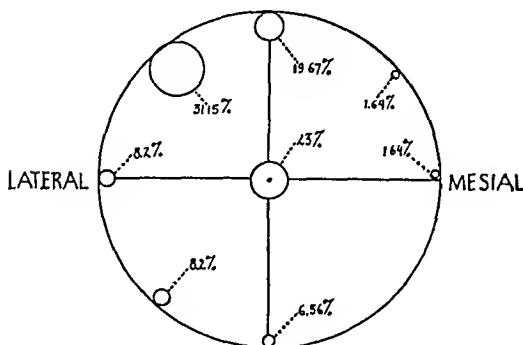


CHART 14.

% 5 YR. CURES BY QUADRANTS

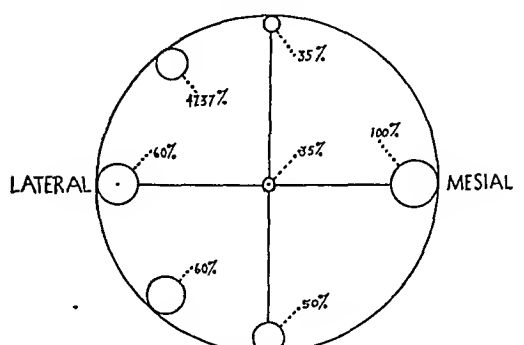


CHART 15.

walked on but two legs, thus interfering with the drainage? The former generation broke down the support of the breast, and interfered with its circulation, by wearing such tight brassieres, and the present woman is doing almost as much harm by wearing practically no support at all. It is encouraging to note the prominence of the breast in the modern styles—the brassiere now being chosen which accentuates the breasts. Though many of these need improving, they are much better than were formerly worn. We feel that the use of the proper type, supporting, but not constricting, brassiere will go a long way toward reducing breast lesions, especially malignant ones. It should be chosen not with an idea of concealing the breast, but rather of supporting it. In extreme cases some form of breast lifting, or plastic operation, is not only justified but also indicated.

Of the deaths, one occurred within a month of the operation, and was apparently not due to her carcinoma. No autopsy was obtained. Two others died, and autopsies proved there was no evidence of carcinoma of the breast but one of these did have carcinoma of the uterus. The one which had had a recurrence but who was now free of disease was not included. Seven were not traced, three of these were known to have recurrences, but four showed no evidence of disease when last seen, two (both graded B and II) having lived over four years. Should the one operative mortality and the two who died from an intercurrent disease be excluded, the percentage of five year cures would be raised to 38 per cent. If the four untraced ones which were free from disease when last seen, be omitted, it would be further raised to 40.3 per cent. Should these four untraced cases be included in the series as five year cures it would be still further increased to 46 per cent.

TABLE VI
RESULT AT END OF FIVE YEARS IN 74 PRIMARILY OPERABLE CASES

Dead	Living but with Recurrences	Died (Other Causes) Autopsy Proved	Living without Evidence of Disease
34 = 46%	3 = 4%	2 = 2.7%	27 = 36.48%
Lost Trace of but Known to Have Recurrence When Last Seen	Lost Trace of But Free of Disease	Had Recurrence But Now Shows No Disease	
3 = 4%	4 = 5.4%	1 = 1.35%	

Of the primary operable cases, 5 (6.7 per cent) had a bloody discharge from the nipple; 3 (4 per cent) had an erosion or crust over the nipple. Skin attachment was noted in 42 (56.7 per cent). In 33 (44.6 per cent) involvement of the axillary nodes was noted clinically; in 30 (40.5 per cent) it was noted pathologically. Primary skin grafts were utilized in 2 (2.7 per

cent). Of 40 cases in which no involvement of the axillary nodes was demonstrated, 19 (47.5 per cent) showed five year cures. In the whole series metastases to bones were noted in 35 (13.4 per cent) cases.

— FIVE YEAR RESULTS —
74 PRIMARY OPERABLE CASES

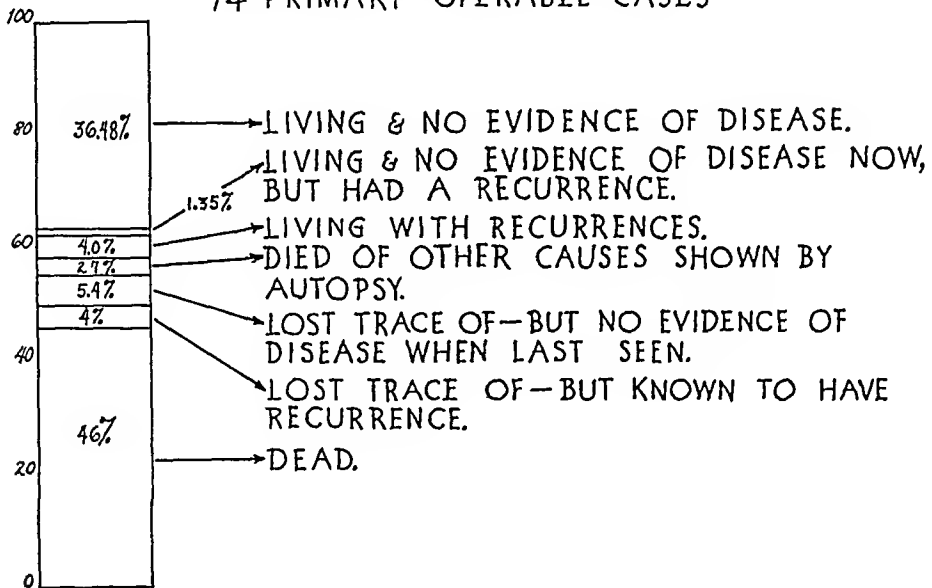


CHART 16.

The routine handling of breast malignancies during this period was, as previously stated, to have preoperative radiation, followed in ten days to three weeks by a radical mastectomy, and then one or more cycles of post-operative radiation. Because of the relatively large number of surgeons involved, this routine varied (Table VII).

TABLE VII

VARIABILITY OF PRE- AND POSTOPERATIVE TREATMENT

Preoperative radiation, radical mastectomy, postoperative radiation.....	13
Radical mastectomy and postoperative radiation.....	6
Excision of nodule, interstitial radium seed, roentgen radiation	2
Simple mastectomy, no radiation.	1
Preoperative radiation and simple mastectomy.	1
Simple mastectomy and postoperative radiation.	1
Preoperative radiation, simple mastectomy, postoperative radiation.	1
Radical mastectomy, postoperative radium.....	1
Preoperative radiation, radical mastectomy.	1

27

It should be noted that in six (22.22 per cent) cases no radical operation was performed and in two of these the tumor only was excised. We do not advocate the abolition of radical surgery, yet so many cases in the five year group who did not have it makes us think. After reporting six cases which had apparently been hopelessly inoperable, but which were living longer than 5 years, Wood says, "These cases have been reviewed to show that neither the histologic nor clinical grading of tumors can be relied upon for the correct

prognostication in the individual case, and that to obtain the best results in cancer therapy all growths, no matter how advanced, must be treated in a thorough and intelligent manner. The biology of the patient and the biology of the tumor, which he harbors, are the two great unknowns present in every case of cancer." But for these "two unknowns," the cases in which a radical procedure is indicated could be better differentiated. Until such time as they become "knowns," the safer procedure will be to give the patient the benefit of every possible means at our disposal.

CONCLUSIONS

(1) In more than three-fourths of the cases a lump is the first abnormality noted by the patient. In one of every 12 cases pain is the first symptom. Certain symptoms, such as painful swelling of arm, diffuse involvement of breast, pain in the lower back, or lump in the supraclavicular region, are more unfavorable than others.

(2) That cancer of the breast may occur earlier than the usually considered "cancer age"—five of this series occurring between 26-30 and eight between 31-35. The peak is reached in the five year period from 51-55.

(3) Only 14 per cent occurred in single persons but in these the percentage of five year cures was less than in those married.

(4) The primary operability of the tumor decreases in proportion to the length of time the lesion has existed, up to the three year period, when there begins a slight increase. The five year cures show a similar increase in the cases which have existed for many years.

(5) Two indices available to determine the prognosis—one, The Clinical Index of Malignancy (Lee), and the other, Histologic Grading of the Tumors. The former seems to be the more reliable, especially in the more hopeless cases.

(6) Eighty-five per cent of primary operable cases occurred in the central or upper portions of the breast. It is thought this may possibly be due to disturbance of circulation due to styles, *etc.*

(7) Thirty-six point forty-eight per cent of primary operable cases are living and free from malignant disease at end of five years.

DISCUSSION.—DR. HUGH H. TROUT (Roanoke, Va.).—There are three points concerning cancer of the breast about which I wish to speak. First, we still believe preoperative and postoperative irradiation is of value. We believe in it thoroughly, and we believe also thoroughly that it is now carrying with it a decided increased danger. There is apparently an increasing tendency throughout the country to do "sloppy" operations and to depend too much on postoperative irradiation. Some are advocating a simple mastectomy for carcinoma of the breast, and depending on irradiation to take care of the nodes that might be involved. We feel that this is distinctly harmful. With the new type of roentgen therapy machines and with the Coutard technic which gives large doses very quickly, I make the prediction that we will see some terrific burns. We have already seen them. However, these burns can be, and are, being prevented, by the more expert radiologists. I am sure that

ultimately these catastrophes will not occur even in the hands of the average technician when the control of these very high voltage machines, and the results of exposure to the same, are better understood.

Radium, unless properly screened, will cause necrosis of the cartilage of the ribs. You will recall that radium is placed in the area supplied by the internal mammary vessels, as well as in the axilla, and therefore, such cartilages are in close proximity to it. Necrosis of the cartilage is one of the most difficult problems with which I am familiar, and when it occurs frequently means the excision of the cartilage.

In visiting various clinics I obtain the impression that the Clinical Index of Malignancy as advocated by Lee and Stubenbord is gaining in popularity, as a means of estimating the prognosis. However, we still feel that both the clinical and the histologic methods should be employed jointly.

I think if we will all study the histories of our cases more carefully we will find a group of symptoms that apparently existed before the carcinoma developed. Along this line, I have in mind the question of painful breast associated with menstruation. Some of these cases can be relieved by the administration of the proper hormone, but, frankly, I do not know which are the proper hormones. There evidently is some definite association between mastitis and hormones.

Apparently the increase in carcinoma of the breast started about the same time as the theory that babies should be removed from the breast early, and that the breasts should not be pumped but allowed to "dry up."

I am hopeful that now with the increased use of a brassiere, that supports the breast instead of pulling it down, it may be of some benefit, for you will recall that carcinoma of the breast is most frequent in the upper, outer quadrant—the site where there is most obstruction due to traction of the old binder brassiere and corsets.

The correction of pelvic conditions may help. We have all seen pelvic conditions that apparently increased the tendency to pain in the breast, which might be a forerunner of carcinoma.

If we study the histories of our cases more carefully we might reach some conclusion as to how to decrease the percentage of occurrence of carcinoma of the breast. At least we might find some condition which will justify earlier and more hopeful operations. Frankly, I am afraid we have, with complete radical operations, plus irradiation, reached the limit of operative cure of carcinoma of the breast, and that now the hope of improvement in this situation rests in the education of ourselves, as well as the laity, in the proper evaluation of symptoms and conditions that might be precancerous.

DR. FRANK P. STRICKLER (Louisville, Ky.).—We see cases of carcinoma of the breast that recur after 20 years. They are being reported more and more frequently. It has occurred to me that we may be using the wrong terminology when we say "cured." We might use "arrested" instead of cured, and then we might not have to take it back. We have heard about carcinoma being caused in the female breast by hormones, lactation, the number of children and so on, but what about the number of carcinomata that occur in the male breast? I think we cannot ignore these entirely. They have the same type of growth and the same type of tissue. I have seen several of these cases and certainly the same etiologic factors do not obtain as in the female. There must be some other reason for carcinoma that we have not considered.

DR. CARRINGTON WILLIAMS (Richmond, Va.).—I wish to mention a case that was operated upon 43 years ago by Dr. Hunter McGuire. The breast was completely removed, but the pectoral muscles apparently were not disturbed. There are no hospital records that we can find but the patient was told that she had carcinoma of the breast. Within the last few months she has had an abdominal enlargement and examination showed that the liver was definitely enlarged and there were several nodules on the liver; it seems reasonable therefore, to believe that she had carcinoma of the breast in 1893 and that she now has carcinoma of the liver. This would tend to confirm the report of Doctors Lewis and Rienhoff, which was the most dismal that I have ever heard. They had followed their cases carefully and some had recurrences after 40 years. I think this report of Doctor Nicolson's is very interesting, and in time such records will help us to find out what really to expect in carcinoma of the breast.

DR. WILLIAM PERRIN NICOLSON (closing).—I agree fully with Doctor Trout. We have not been using the Coutard technic in operable cases. Our routine calls for a cycle of four treatments through relatively small ports, including the breast, tumor and axilla.

I did not mean to say that I considered these cases which were free of disease at the end of five years were "cured." I doubt if a case of carcinoma of the breast can ever be considered as "cured," in that they may occur even after an incredible number of years, as in the case Doctor Williams reports. Every case should have periodic postoperative examinations as long as she lives.

THE ULTIMATE PHASE OF LIFE AS IT RELATES TO WOUNDS OF THE HEART

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On July 16, 1927, a male, aged 20, was admitted to St. Joseph's Hospital, having been shot some 20 minutes previously. The patient was in shock, almost pulseless, but conscious, with a bullet wound in the third left interspace three-fourths of an inch from the sternal border. The physical signs indicated a wound in the heart. Within 30 minutes after the accident he was operated upon under light ether anesthesia. An incision was made through the cartilages to the left of the sternum following the Kocher procedure. Before reaching the pericardium the patient's heart action ceased entirely. The writer remarked, "I have never before operated upon a heart wound, let's just go ahead and complete the operation on the cadaver." So deliberately, and without haste, the chest was opened widely, cutting through the pleura as well as the pericardium, releasing the clot and fluid blood from the pericardial sac. The heart was motionless in the back of the cavity with dark fluid blood pouring in a steady stream from an opening in the right ventricle; the wound was a long tangential one tearing through into the right ventricle and making a trough in the muscle of the left ventricle and the interventricular septum about two inches from the apex. Holding the heart in the left hand a suture of chromic catgut was placed to close the opening. After placing the second suture a slight crawling movement of the heart was felt. This was repeated again after the next suture had been introduced, a little stronger than before and again and again until by the time the wound was completely closed the heart was beating normally. The patient left the table in fair condition.

Following the operation he developed a purulent pericarditis which was aspirated several times and an empyema of the left pleural cavity, which had to be drained, but he finally recovered and is at the present time in good health.

The massage together with the needle pricks which the heart received during the procedure were sufficient to set it in motion again. The interval of complete cessation of heart beat was probably about ten minutes. No effort was made at artificial respiration as the patient was supposedly dead.

The case itself, besides contributing to the writer a tremendous reaction from having a supposed cadaver come to life while holding the heart in his hand, was regarded merely as one of those extraordinary happenings that occurs occasionally in the experience of every surgeon. Within the past year, however, attention was called to the work of Doctor Cornish of California on "Resuscitation of Dogs." Hymans' researches on the same subject with special reference to restarting the stopped heart with his pacemaker were reviewed. Subsequent investigation of the entire subject of resuscitation in the Library of the Surgeon General at Washington was undertaken and justifies the following statements.

That there exists an ultimate phase of life after the heart and lungs cease to function in which it is possible to restart these functions.

That the duration of this ultimate phase has not been definitely deter-

mined and that it probably varies with different individuals, with age, and with preceding condition of vigor.

That the cells of the centers of circulation and respiration withstand deprivation of blood (oxygen) longer than do the cells of the cortex.

That deprivation of blood (oxygen) from the cortical cells beyond a certain point, even if life is restored, results in harmful changes in personality.

That the actual time in minutes in which human life has been restored without injury to the cortical cells after the heart and lungs have ceased to function has varied in the reported cases from eight to 30 minutes.

With this light upon the case here reported it is evident that the result was not just an accident but was one that may be reasonably expected under similar conditions.

Death from heart wounds is due to hemorrhage or heart compression. Where the pericardial tear is large, death occurs rapidly from bleeding into the pericardial sac. When it is small death is due to a gradual compression of the heart and the process consumes a longer time. It is this latter class that has furnished the favorable surgical material.

Since Rehn first reported in 1897 the successful suture of a heart wound, the literature on the subject has been steadily increasing. No fewer than 44 articles on this subject are cited in the Index Medicus during the past two years. In a review of this literature the reader often met with the expression "the patient died on the table and the operation was discontinued" or "patient expired before anything could be done." It is the purpose of this paper to draw attention to the fact that there still remains the ultimate phase of life; that the patient is at first not really dead, even though his heart has ceased to beat and air no longer enters his lungs; that the surgeon still has time to do what should be done. It may even be shown by further experience that on account of the rapidity and ease of its performance and on account of the lessened danger of exsanguination, the ultimate phase may provide better figures from the standpoint of recovery than the penultimate or just preceding period. The fact that the patient is in the stage commonly called the "article of death" is no contraindication to operation.

And, finally, it is the author's opinion that if all patients with heart wounds dying in the ambulance, or shortly after admission, are sent not to the morgue but to the operating room and operated upon immediately, some of them will recover.

SUPPURATIVE PERICARDITIS

LATE RESULTS AND METHODS OF DRAINAGE

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FROM THE UNIVERSITY HOSPITAL CLINIC, BALTIMORE, MD.

DOCTOR GEORGE H. BUNCH¹, in 1934, presented four personal cases of suppurative pericarditis before the Southern Surgical Association. Doctor Nathan Winslow and the writer,^{2, 3} collected 227 reported cases of pyopericardium up to January 1, 1934, 12 of which were personal experiences.

After having operated upon 12 cases of pyopericardium with seven recoveries and five deaths, I am discussing this condition with two objectives in mind, one of which is to report the present condition of the patients who recovered, and the other is to bring up the question of adequate drainage.

There is a widespread belief that most patients operated upon successfully for pyopericardium are thereafter seriously crippled by adhesive pericarditis. One would naturally expect such a result. In 1929, Horine⁴ reported his findings on dogs whose pericardial sacs were infected by injecting either pneumococci or staphylococci into them, then dropping them back into the thorax and closing the wound in the chest. In all of these dogs the postmortem findings were essentially identical, adhesive pericarditis with collections of pus in the auricular areas or lateral recesses, complicated by extensive infection of neighboring structures.

Beck and Moore⁵ made a transpleural approach under positive pressure anesthesia and injected the pericardium, afterward closing the chest wall. Some of these dogs recovered and a number died in a few days.

When the condition of the pericardium at operation is considered and when the effects of drainage within a serous cavity are observed, widespread adhesions between the two layers of the pericardium more or less obliterating the pericardial space seem inescapable. And when the very active heart is visualized, in repeated systole and diastole, one is surprised that it continues to adequately perform its work in the presence of such pathology. But there is abundant proof that such a heart does continue to do its work without clinical evidences of any serious lessening of its ability to function.

In many of the cases collected by us, no statement was made beyond the fact of operative recovery and no conclusions can be drawn from these. Fortunately, however, 39 cases are available in the literature, in whom at least one year had elapsed since the pericardiotomy. Thirty-five of these patients were alive and well at the time of the report, with their cardiac boundaries within normal limits. One was alive but had adhesive pericarditis, and his death was momentarily expected. Of the three remaining one had died three years after the pericardiotomy, but the cause of death was not known; one

had died of an abscess of the brain a year later and one of an adhesive pericarditis.

I have been able to keep in touch with six of the seven recovered cases in my own series. The one patient whom we have been unable to locate was a girl, 12 years old, who was operated upon January 25, 1927. She had a stormy convalescence for two weeks and then made a rapid recovery and was discharged March 16. She was followed for several months, but was lost sight of and has not been examined since.

All of the remaining six were young persons—4, 9, 17, 18, 19 and 29 years old respectively. Only one had an associated empyema and he was the oldest. In five of the seven the pericarditis complicated pneumonia; in one it followed scarlet fever, and in the youngest, 4 years old, tonsillitis and otitis media with arthritis preceded the pericarditis. This patient was operated upon in June, 1924. Paracentesis pericardii was performed before operation and a pneumococcus, of no fixed type, was grown from the serosanguino-purulent fluid. He had a stormy and prolonged convalescence. After all evidence of acute infection had subsided, and his drainage wound had healed, he continued with the symptoms of serious cardiac damage for several months accompanied by anasarca, ascites and dyspnea. His peritoneal cavity was tapped several times. The fluid was clear and showed no growth. His heart was enlarged but no signs of mediastino-pericarditis could be made out. Whether adhesive pericarditis or myocardial damage was playing the major rôle we were unable to say. If the pericardial effusion had not been purulent and associated with a pneumococcus, we would have felt that we had performed pericardiotomy for pericardial effusion, associated with rheumatic fever. I have seen the boy many times since. He is now nearly 16 and is large for his age, robust, active and with no evident disability.

Another of these patients had a slow convalescence. She was 19 when operated upon in 1929. Her pericarditis complicated pneumonia. The pus was thin, under pressure, and gushed from the incision. Two small tubes were placed behind the heart for drainage and sutured to the skin. For several days her condition was desperate and on the fourth day irrigation was begun. Her condition improved, but even two months after operative recovery she had considerable shortness of breath when she was very active. Again we could find no evidence of mediastinopericarditis or of constricting pericarditis. She has now completely recovered clinically, and is not conscious of any disability.

In another patient there was an unusual complication. This was a girl, 9 years old. Her pericardium was drained with two small rubber tubes. She did well for two weeks and then had fever with hurried breathing and a fast pulse. Roentgenography showed a suspicious enlargement of the cardio-pericardial shadow to the left and in the region of the base of the heart. A walled-off pocket was suspected and found by removing the drains and following with the finger along the drainage tract, posterior and lateral to the left ventricle. This patient is now grown and married. She is clinically well.

A boy, 17 years old, was operated upon in 1930. He had a history of valvular heart disease preceding his illness, which complicated scarlet fever. His pericarditis was purulent and a hemolytic staphylococcus was recovered. He made a rapid and satisfactory recovery except that he developed thrombophlebitis in one leg. I saw him recently. He is now active. He still has his valvular lesion, but his heart is compensated. When he has a long, hard day, he has some swelling in the leg, the result of the phlebitis. His future is, at best, uncertain but his circulatory system is carrying on in spite of a triple handicap.

The 18-year-old boy was operated upon in 1925. After recovery he passed the physical examination for admission to the Naval Academy, but was rejected because of the history of suppurative pericarditis. He reports himself in good health. The last case was operated upon two years ago. He writes that he is well. Dr. Harvey Stone operated upon a second case several years ago with recovery. This patient has no clinical evidence of disability.

Of the cases that recovered all were operated upon early. Most of them were seen in consultation with Dr. M. C. Pincoffs. Of the five fatal cases, only one was a late case, he was also the oldest patient. That defective drainage played very little part in the fatal outcome in this series is suggested by the fact that the time factor between pericardiotomy and death was short in all five cases; a few hours, the next day, 26 hours, 12 hours, a few hours, being the respective notes attesting to this time period.

It is easy to understand why patients operated upon for suppurative pericarditis should succumb to early complications and infection and later to adhesive pericarditis. In only one of our cases was any attempt made to suture the edges of the pericardium to the sides of the incision in the chest wall. The middle portion of the lower mediastinum is occupied by the heart and pericardium. The outer layer of the pericardium is attached to the heart and to the middle of the diaphragm over a considerable area surrounding the quadrate opening through which the inferior vena cava passes from abdomen to right auricle. With this exception the heart lies free in the pericardial sac which extends upward onto the great vessels for a distance averaging 5 cm. A part of the outer layers of the pleurae are in intimate contact with the outer layer of the pericardium, but these structures are not adherent.

One would expect pus to gravitate from the opening in the pericardium downward along its outer surface and set up some reaction between itself and the enveloping pleurae. One would also expect some evidence of posterior mediastinitis. Postmortem findings have not been very accurate in most instances. The usual operation for pyopericardium is through the "triangle of safety" by removal of some part of the chest wall immediately in front of the left ventricle. This is the region in which crippling mediastino-pericarditis is seen and for which the Brauer operation is indicated, but I do not remember any report of this operation having been performed for mediastino-pericarditis following drainage of the pericardium.

On the other hand, there is no reason why the pericardium, thickened and

inflamed and adherent as the result of infection followed by drainage, should not undergo fibrosis and contraction bringing about constricting pericarditis calling for pericardiectomy, but I do not recall that any of the 37 pericardiectomies collected by Churchill⁶ were undertaken to liberate the heart in any patient where the concretio pericardii was preceded by pericardiotomy for suppurative pericarditis.

There are many ways in which chronic adhesive pericarditis shows itself anatomically and these different phases may be visualized under four heads. First, adhesions between the inflamed pleura and the outer layer of the parietal pericardium, seen commonly in unilateral fibroid phthisis where the heart and pericardium are pulled somewhat into the diseased side of the chest. Second, mediastino-pericarditis. Third, constricting pericarditis, and fourth, adhesions between the two layers of the pericardium, more or less obliterating the pericardial sac, but without constriction and without the pericardium being adherent in turn to the unyielding chest wall. In this type of chronic pericarditis the heart is perhaps not seriously handicapped in its movements because under normal conditions the pericardium follows the heart closely. It is possible that many of the patients who are clinically free of cardiac disability following pericardiotomy belong in this last group and the individuals who are victims of cardiac disability following pericardiotomy may suffer from some combination of the different types of chronic pericarditis.

METHOD OF APPROACH.—Emphasis had been laid by most operators on the "triangle of safety" and the approach through the chest wall has usually been either a left or right parasternal, a trans-sternal, a chondroxiphoid or some combination of these. In the last two cases operated upon by me a modified approach was made combining the trans-sternal with the chondroxiphoid. This is a low anterior approach and gives a wide exposure of the uncovered pericardium between the medial margins of the two pleurae, brings the margin of the left pleura into view and exposes the left internal mammary vessels just above the diaphragm. It is a low approach in the caudate cephalad axis of the body and allows a wide opening which permits exploration of the pericardial sac by the finger, which is an aid in estimating the extent and location of the effusion and the presence of adhesions which might lead to walling off of the exudate, and in placing the drains. In the dorsal-ventral axis, however, this is an anterior approach, and with the patient lying on his back the drainage is directly against gravity. The movements of the heart have some tendency to promote drainage and attempts have been made to improve it by changes in the position of the patient.

In the absence of adhesions, the apex of the heart is usually found in close proximity to the anterior layer of the parietal pericardium and most of the pus is posterior and lateral to the heart. When a part of the fluid escapes, the ventricles are apt to interfere with anterior drainage, unless drains can be maintained in position either posterior or lateral to the heart. This anterior approach has therefore been objected to, and has been found unsatisfactory at times, especially in instances of shaggy pericarditis where there are masses

of coagulated fibrin which repeatedly plug the drainage tract, or where there is a long standing effusion with a very large and adherent pericardium.

Posterior drainage has been considered and tried, but the difficulties and risks are very great. The vertebral column and the structures in the posterior mediastinum are in the way when attempting an extrapleural posterior approach and a paravertebral approach can be made only by going through the pleura and the lung, provided the risks of going through the posterior mediastinum are avoided. Both Truesdale⁷ and Cottam⁸ writing in the same year, 1933, criticize the anterior approach for the reasons mentioned above and each reports a different posterolateral approach. Ballance, in his Bradshaw lecture, discusses this problem because of his experience for three and one-half weeks with a posttraumatic case which finally succumbed. Cottam drained a case successfully by locating pus by paracentesis and with the needle in place followed it by removal of the right fifth costal cartilage, incising both layers of the pleura, which were adherent, and by burrowing backward, he opened the pericardium well away from the front. On introducing his finger he felt the heart anterior and to the left and inserted a large, soft rubber tube backward and upward until he met resistance. A number of objections may be raised to this procedure, but he succeeded in getting good drainage and his patient recovered.

Truesdale lost a patient in 1910, 16 days after anterior drainage, by approaching the pericardium through the left fourth and fifth chondral cartilages. In 1932, he saw another case of pyopericardium and against his better judgment again drained the pericardium through the region of the left fourth and fifth cartilages. When the pericardium was opened approximately 2,500 cc. of pus escaped under great tension, but the patient continued ill and drainage was greatly interfered with by clumps of fibrin. Twenty days after operation the patient became worse and after transfusion a horizontal incision was made in the left seventh interspace beginning at the nipple line and extending outward to the posterior axillary line. About two inches of the seventh and eighth ribs were resected. On opening the pleura the pericardium was seen resting on the diaphragm and the lung and pleura were adherent to it. It was necessary to dissect these overlying structures away before opening the pericardium. The pleural cavity was not opened. Through and through drainage was established and the patient promptly recovered.

Heuer⁹ had the same experience. When he resected the left fifth costal cartilage he found the heart adherent to the parietal layer of the pericardium, and efforts to separate the adhesions were damaging to the heart muscle. The patient was placed on his side and a rib in the left posterior axillary line was resected; the pleurae and lung were found adherent and the pericardium was reached through a corridor in the lung and the patient recovered.

Loucks¹⁰ reports an instance of suppurative pericarditis following a wound of the chest. Anterior drainage by left parasternal approach through the cartilage of the sixth rib was done. No drainage tubes were used. Drainage was not satisfactory and several days later a localized empyema was drained

after resection of the eighth rib posteriorly. Thirteen days after the anterior pericardiotomy the pericardium was drained posteriorly through the posterior opening made for draining the empyema. This patient recovered.

Moore¹¹ reported a left sided posterolateral drainage similar to that of Truesdale, and with the same findings as to distended pericardium and adherent lung and pleura. There had been no previous anterior pericardiotomy.

In all of these cases the pericardium was reached in the posterolateral plane and as far as the heart was concerned the drainage was from behind. The fortunate thing in each instance was that the free pleura was not opened and no pyopneumothorax resulted. In large, long-standing effusions anterior drainage may be insufficient and the chances are in favor of reaching the pericardium laterally without opening the pleural cavity. The above reports are a very valuable addition to our knowledge of the subject.

In early suppurative pericarditis, when the pus is still thin and before distention of the pericardium is marked and before adhesions between pericardium and pleura may have had time to form, any approach except through the "triangle of safety" is apt to open and infect the pleural cavity. Pyopericardium and pyopneumothorax in the same patient at the same time offers a bad prognosis.

CONCLUSIONS

All the patients that I have operated upon, except one, were relatively early cases. I believe that the low anterior approach is better than the higher parasternal one through the level of the fourth and fifth costal cartilages. Tube drainage with two small tubes, placed with the finger, behind the heart and fastened to the skin margins to prevent displacement will expedite drainage and irrigation may be a useful adjunct, provided fluid escapes from the pericardial sac as fast as it is introduced.

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DISCUSSION OF THE PAPERS OF DOCTORS BULLOCK AND SHIPLEY

DR. ALBERT O. SINGLETON (Galveston, Tex.).—Wounds of the heart usually occur at a time of day when the attending surgeon is not available.—Most commonly at night, when the younger surgeons in the hospital have the responsibility of caring for them.

I have been of the opinion that a plan should be formulated by which we may expedite the prompt care of these patients. This plan of procedure is based upon the study of the cause of death in stab wounds of the heart which I have previously discussed.¹

The causes of death, in those cases where time is allowed for something to be done for them, are usually from one of three conditions.

- (1) Heart tamponade or compression.
- (2) Hemorrhage into the pleural cavity.
- (3) Infection following operative procedure either in the pericardial or pleural cavities.

Upon examining the patient one can usually tell if the heart has been wounded and can also from the symptoms tell whether or not the patient is suffering from heart compression or from the loss of blood. If the thoracic cavity is filled with blood, then the wound has penetrated both the thoracic and pericardial cavities and the patient is losing blood into the thoracic cavity and may die of hemorrhage; but naturally will have the signs of hemorrhage in addition to the physical signs of hemothorax.

On the other hand, if the wound has gone through the chest wall into the pericardium without wounding the pleura, the blood will accumulate in the pericardium because it cannot escape through the stab wound. The patient therefore will have symptoms of heart compression which are entirely different from those of hemorrhage. The patient whose pleural cavity has not been wounded should be approached with great care in order not to open the pleura; while in the patient whose pleural cavity has been wounded and filled with blood, the transpleural approach is preferable. In the latter case the pleural cavity should be emptied of blood, the heart wound sutured, pericardium closed, pleural cavity closed air tight, and the air removed from the thoracic cavity and the lung immediately inflated.

To avoid the third cause of death one should never, in the hurry and excitement of the procedure, neglect the rules of asepsis, which should include a thorough débridement of the wound down to the ribs, complete removal of all blood in the thoracic cavity, closure without drainage and in every way guard against infection. I have seen two patients die of infection after the successful suturing of the heart, where if this rule had been observed these patients would probably have lived.

In conclusion I should think that if the younger staff about the hospital are trained to approach these cases with these points in mind, many more patients would be operated on early and many more of them would recover.

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DR. ROBERT L. RHODES (Augusta, Ga.).—In 1924, I presented the report of two cases of wounds of the heart before the Southern Surgical Association, one patient alive and well—incidentally, still alive and well. In the report of the first patient I tried to stress the point Doctor Bullock has brought out. I called attention to the fact that the heart was kept beating for 45 minutes after the patient was apparently dead, by repeated massage and the use of salt solution and adrenalin. I did this to emphasize that these patients are not dead. What the phase is we do not know.

The patient who died had a wound in the left ventricle and was exsanguinated. I called attention to the fact that if I had another such case to deal with I would aspirate that blood and reinject it in the form of a ventricular infusion or into the veins.

I wish to second what Doctor Singleton just said about educating the young men to recognize and properly treat these cases. Recently we had two instances that were not recognized. Given stab wounds of the chest, the patients do not die quickly. It is not the emergency one might think. You may have time to have a roentgenologic examination made. In both of my cases the left pleural cavity was involved and there was no difficulty in recognizing the presence of a hemothorax.

I wish to add a fourth fact: these two recent cases both died of cerebral emboli. The blood clot in the ventricle was pinched off and the cerebral vessels in both cases were full of emboli. Cerebral emboli constitute, therefore, a fourth cause of death.

I would like to add one case to Doctor Shipley's report. Following the paper of Dr. George H. Bunch last year, I went home and saw a man who had had an empyema probably for three weeks before he was brought in. Three days after the empyema had been drained we found his pericardium needed to be opened, because of suppurative pericarditis. This was done and he made a satisfactory convalescence for nine days, when he awakened from his sleep about midnight and asked the nurse to hold his hand because he was going to die. She sent at once for the house officer. He could find nothing wrong, but the patient was dead within an hour. The autopsy failed to show the cause of death.

THE DEVELOPMENT OF SELECTIVE EXTRAPLEURAL THORACOPLASTY FOR PULMONARY TUBERCULOSIS

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THROUGH an era of change and progress, it is natural to anticipate variation and modification in the operative procedure of any disease; especially, of a pathology in which surgery has only recently—within the past two decades—proved its value. The early advocates of extrapleural thoracoplasty for pulmonary tuberculosis were of one opinion as to its surgical technic. A resection of the first to the tenth or eleventh ribs, inclusive, was completed in practically every case of this type. Any lesser procedure was held to be useless and thought to leave the patient in a precarious condition. So dogmatic were Sauerbruch and others on the importance of a complete surgical collapse for every case that one hesitated to change in essential detail the so called standard operation.

We should not underestimate the experience and opinion of the leaders in specific fields. Important also is the surgeon's responsibility for the significance of improved results in his own cases; that, clinically alert, he may evaluate such results in terms of surgery, and shall profit thereby. No rigid adherence to former precept, however standardized, can develop the usefulness of any surgical procedure.

For several years, in my work in the field of thoracic surgery, I performed, as generally advocated, the complete extrapleural thoracoplasty in all cases of surgical collapse. In spite of its epochal importance, the disadvantages of this extensive "complete operation" were constantly obvious. While offering hope to a large group of desperate patients, it exacted a maximum of shock, disability and economic loss, and carried a threatening operative mortality. In 1932, our first inventory of 100 cases of extrapleural thoracoplasty for pulmonary tuberculosis caused us to draw an important deduction. At that time about two-thirds of our cases had had the complete operation. The remaining 33 had had so far a *selective* operation directed simply at closing the existent cavity or cavities, with no effort made to compress any part of the lung undamaged by tuberculosis. The improvement in these cases of selective thoracoplasty was greater and more significant than the figures would indicate.

Encouraged by such pioneer results, we proceeded boldly in a more radical departure from the standard operation, finding the selective thoracoplasty suitable for an increasing number of our cases, and became convinced of its importance in the development of thoracic surgery. We had been warned of certain grave complications to be expected if we began at the top instead of at the bottom in our resections of ribs; also of what would surely follow if we did not complete the standard massive operation in every case. But

from our earliest use of selective surgical collapse, there occurred no extension of pathology into the opposite lung, nor was it followed by any extension into the healthy part of the lung under operation. The dire warnings had failed to materialize. And with serious thought, we continued to alter definitely our standard type of operation for pulmonary tuberculosis.

Having laid down as our basic principle that "one should always adapt one's operation to the pathologic condition present," we no longer routinely began at the base and resected, in stages, all the ribs. Instead, we took increasing care to *select* for every patient the type and extent of operation best suited to his individual case. If only the apex was involved, as in the majority of cases referred for surgical collapse therapy, it was carefully determined what ribs should be resected and what lengths of ribs should be removed in order to collapse the cavity or cavities completely.

Logically the next question followed: Why not exert every effort to impair as little as possible the function of the remaining healthy part of the lungs? The purpose of every extrapleural thoracoplasty of whatever degree is to close cavities and to put the diseased lung at rest. It is not directed toward limiting the function of an undamaged lung. Too often, in the collapse of any cavity, some good lung tissue is compressed. We believe, however, that the selective thoracoplasty does the least amount of damage to healthy lung tissue.

Vital capacity, as emphasized by Graham, is an essential factor in doing extensive rib resections in cases of pulmonary tuberculosis. When only the partial or selective collapse is carried out, vital capacity plays a less important rôle. If only the damaged part is compressed, the effect on the lung in this respect is frequently negligible.

In any study of a series of pulmonary collapse, it is surprising to note how few cases justify resection of all the ribs. Operable cases usually have no extensive cavitation throughout the lung. A case so unfortunate is the late neglected type rarely seen in a modern tuberculosis hospital. The phthisiotherapist, scrutinizing each case routinely and more vigorously than in the past, now promptly refers all cases suitable for surgery while their cavities are small and ready for selective collapse treatment. The neglected tuberculous patient who has been unwisely advised or treated "expectantly" too long, is the case least suitable for the operation we advocate. On the other hand, if the case has been followed from its incipency by a capable physician schooled in tuberculosis, indications for the standard extrapleural thoracoplasty, as popularized by Sauerbruch, will be the exception. Rest, pneumothorax, pneumolysis, phrenic surgery, or finally, a selective thoracoplasty will be our usual procedure.

Bilateral cavities at the apex are readily collapsed by bilateral selective thoracoplasty. Since, by this type of case, the complete thoracoplasty could not be borne, such a patient would never be suitable for the complete operation and would be given up as hopeless. We refer with interest to the frequency of indications for apical thoracoplasty based on Medlar's recently

published pathologic theory. His experiments with sections of whole rabbit lungs have shown that tuberculosis unerringly seeks the highest area of the lung, basal or apical according to posture. He states that: "The main seat of chronic cavitating tuberculosis in rabbits and cattle is the posterior ventral surface of the posterior lobe." Due to posture, the base is thus the more elevated portion of the rabbit's lung, relative in plane to the human apex, in which location tuberculous cavities most frequently occur. It has further been proved possible to bring about a change of location of the progressive tuberculous process in the rabbit lung by changing his posture.

Our experience with selective collapse therapy dates from 1924. After five years' work we first advocated this procedure before the Association for Thoracic Surgery. No interest in our recommendation of upper or partial thoracoplasty was particularly evidenced at that time. We again ventured to report our results in 1932. When first presented before this Association in the same year, it aroused slight and conflicting discussion. At that session, Dr. Louis Franck definitely "questioned the possibility of securing the necessary and desired collapse by the plan advocated." Doctor Boland admitting that our work appealed to him, asked "If the lower portion of the lung is in good condition, why collapse it?" Still more favorably, Dr. George Bunch agreed that "with a cavity in the apex, if there is not much involvement of the lower portion of the lung, I think this type of procedure is indicated."

To date, Dolly reports 120 cases of apical thoracoplasty. O'Brien states that he too is now doing a limited thoracoplasty. Overholt, from Lahey's Clinic, reports partial thoracoplasty on 53 cases with pleasing results. Mr. W. H. C. Romais and Mr. S. H. Sellars of London report favorably on a series of such cases. I have not found any series of limited or selective surgical collapse that has shown unfavorable results. It is significant that the surgeons who have been doing this work are universally enthusiastic about it. That others are now getting satisfactory results with the selective operation, and that none of the complications formerly predicted have materialized in their cases, are matters keenly gratifying to us. It means, I frankly think, that only recently has this useful operation been fairly tried, and that little accuracy was formerly recorded as to its results. In spite of such development, however, it is apparent from a survey of today's literature that the standard operation of Sauerbruch is still the technic commonly practiced by the majority of surgeons.

The indications for a selective thoracoplasty are similar to the indications for the complete operation. We have stressed the importance of an earlier and less severe operation. But let us keep clearly in mind the fact that surgical collapse by resection of ribs should always be considered as a last resort and that no patient should be subjected to a thoracoplasty of any extent until all other suitable means of treatment have failed. There are many less severe types of collapse therapy which should be tried before we resort to rib resection; remembering, particularly in the case of resection of all the ribs, that the lung thus compressed is definitely and permanently *hors de*

combat. This warning applies also to the use of partial or selective thoracoplasty.

The selective operation differs little in technic from that of the standard thoracoplasty. Each resection must be planned according to the condition of the patient, and the size and location of the cavity or cavities to be closed. If the cavity is larger and located high in the apex, greater lengths of the upper ribs should be resected. If it is small, a relative amount of the ribs should be removed. In resections of the upper four or five ribs, we make use of an ample incision. This enables us to lift the scapula well forward so that any lengths of the first and second ribs may be exposed. An adequate exposure is vital in removing the upper ribs. We must close the cavity, regardless of the amount and number of ribs to be resected. Not infrequently, anterior sections of the ribs must be removed to accomplish a complete closure of the cavity and a negative sputum. Paralysis of the diaphragm by operation on the phrenic nerve has been popular in the surgical treatment of pulmonary tuberculosis. We have used it selectively as indicated, but not as a routine measure.

Briefly summarized, the advantages of selective thoracoplasty are these: It is less severe and less shocking; thus allowing us to operate on many patients who would otherwise be denied surgery. The number of stages of operation are fewer, since nearly all selective thoracoplasties can be done in one stage; a point important to the patient as well as to his family. Further, as above mentioned, and as our series will show, bilateral cases stand the limited or selective operation exceedingly well; this, because the healthy part of the lung continues to function without embarrassment. By virtue of such versatility, the field of thoracic surgery is distinctly broadened through the practice of a limited surgical pulmonary collapse.

The selective operation interferes very little with cough and expectoration; an important advantage. Statistics show that the standard operation of Sauerbruch predisposes to the development of pneumonia. The resection of the lower ribs interferes seriously with postoperative cough, with resulting stasis. In selective thoracoplasty, stasis is not a troublesome factor, because coughing and expectoration are little disturbed. The percentage of pneumonias following the selective operation is relatively low.

SUMMARY.—A few outstanding facts mark the survey of our series of cases of selective thoracoplasty. (1) From the present favorable condition of several patients operated on 11 years ago, the principle involved in selective collapse therapy is shown to be sound. (2) The fear of promoting an extension of the disease into healthy lung tissue has entirely failed to materialize. (3) This type of operation broadens the field of usefulness because it is less severe and more applicable to bilateral cases.

It is interesting to note that all of my cases were studied and selected through consultation with Dr. Dean B. Cole and his associates. The results here given are the reports from the medical staff. I feel very strongly that this selection of cases is the determining factor in our surgical success. Real

progress depends on early, intensive application of the type of therapy best suited to the given case.

We have done selective thoracoplasty on 67 of our cases with an operative mortality of 5.6 per cent. Since December 1, 1932, 90.4 per cent of our cases have had a selective thoracoplasty only. Our whole principle has been to close cavities, doing as little damage as possible to the healthy lung tissue; and to render the sputum free of tubercle bacilli.

THE TECHNIC OF THORACOPLASTY FOR PULMONARY TUBERCULOSIS

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TEN years ago I performed my first thoracoplasty for pulmonary tuberculosis. Since that time, 159 additional cases have been operated upon. On looking back upon this first case, which was done in 1925, it is apparent how much the present technic differs from the original one.

In 1885, De Cérenville performed what is considered to be the first real thoracoplasty. His operation consisted of the resection anteriorly of short segments of ribs over tuberculous cavities at the apex of the lung. Several other surgeons, notably Carl Spengler, Quincke and Garré performed operations quite similar to that of De Cérenville, in that very short segments of a few ribs were removed. The results of these operations were poor and the operation did not become popular. In 1907, Brauer, feeling that the poor results of these first operations were due to the removal of too short segments of a few ribs, advocated the removal in a single stage of the entire length of ribs II to IX, inclusive. Friedrich performed such an operation in 1907. Though his first patient survived, the mortality in the subsequent operations was 30 per cent. Wilms, in 1911, demonstrated clinically the value of the experimental work of Boiffin and Gourdet by the good results he obtained in cases of pulmonary tuberculosis in which he resected short lengths (3 to 5 cm.) of ribs I to VII close to the spine. The mortality was much lower than that of the Brauer-Friedrich operation. Wilms later modified his original operation in that he removed somewhat longer segments of ribs and extended the operation to include ribs I to X. Sauerbruch, working independently, advocated practically the same operation. John Alexander, in his exceptional monograph, "Surgery of Pulmonary Tuberculosis," published in 1925, speaks of this last operation as the "Wilms-Sauerbruch" and states, "It is the technique, although sometimes slightly modified, that is being used throughout the world by most surgeons of experience."

Thus it can be seen that from its beginning in 1885 up to 1925 the operation of thoracoplasty had passed through the phases of short rib resection, very long rib resection, and finally of removal of short segments of ribs. This was the technic of the operation at the time I first became interested in it. The essential features of the operation at that time were (1) the resection of 2 to 3 cm. of the first rib, 3 to 5 cm. of ribs II to VII, and 6 to 15 cm. of ribs VIII to X or XI; (2) the removal of the lowermost ribs at the first stage followed in two weeks by the removal of the upper ribs, and

(3) the resection of ribs I to X or XI in every case regardless of what was the underlying pathology in the lung.

After a few years' experience with the above described technic, it became evident to me that the operation which I was doing was not closing cavities in the lung completely, unless the cavities were small, or unless there was little fibrosis about them. This same feeling was experienced by many other surgeons and supplementary thoracoplasties were done anteriorly to increase the collapse in cases in which the original operation had proved to be inadequate. The result has been that increasingly long segments of ribs overlying cavities have been removed until at present practically the entire rib from spine to sternum is resected. This removal of great lengths of ribs over the most diseased portion of the lung is regarded as essential in the present day thoracoplasty and will, I believe, contribute more than anything else to the complete and permanent closure of a tuberculous cavity. The collapse of the chest wall as seen at operation in my early cases, with resection of short portions of ribs, was very inadequate as compared to that obtained now by the removal of practically the whole first rib and of great lengths of all ribs over a cavity. A number of my earlier cases have had to be reoperated upon in order to close cavities which were not completely collapsed because of the inadequate removal of ribs. I now feel strongly that there is no standard operation which is suitable for all patients, but that the operation has to be made to fit the needs of the individual patient, in that varying lengths of ribs and varying numbers of ribs should be removed depending on the character of the lesions in the lung.

From 1925 until 1931, I regularly resected ribs I to X inclusive in all cases and removed the lower ribs at the first stage. The rationale of the primary removal of the ribs from the lower portion of the thorax was that by compressing the lower lobes first, one prevented aspiration into them of infected material which was forced into the bronchi when the cavities at the apex were compressed. This danger of aspiration is not considered as real now as it formerly was, probably because a phrenicotomy is being done preliminary to most cases of thoracoplasty, and the amount of compression thus afforded the lower lobes guards against aspiration. It would seem more logical to remove the ribs over the upper portion of the chest first because the apex is usually the most diseased portion of the lung and contains the cavities, for the obliteration of which the operation is performed. A further reason for the primary removal of the upper ribs is that, if the second stage of the operation has to be abandoned or long delayed after the first stage, the cavity in the apex will have been completely or partially collapsed. The patient will, therefore, have a better chance of recovery than if the size of the cavity had been unchanged by an operation performed on ribs far removed from it. Therefore, for the past several years the uppermost ribs have been resected at the first stage, proceeding from above down rather than from below up, as was formerly the case.

I find myself growing more and more conservative in the amount of

operating done at any one stage. It has been found to be wiser to err on the side of doing a good deal less than the amount the patient will tolerate rather than doing too much. Whereas formerly five ribs, and sometimes six, were resected at a single stage, at present only three ribs and occasionally

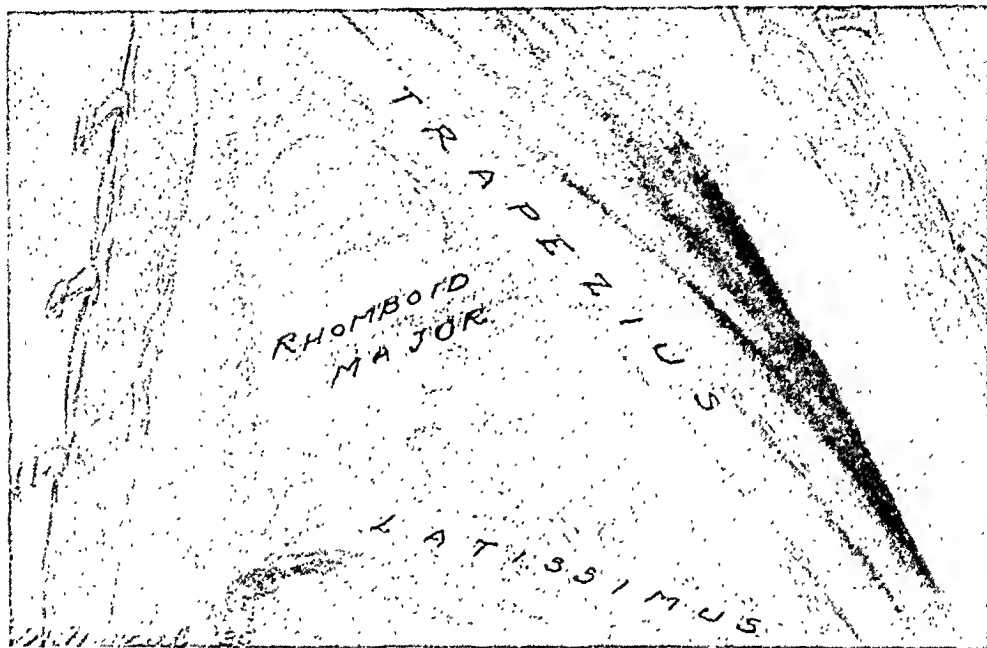


FIG. 1.—The auscultatory triangle.

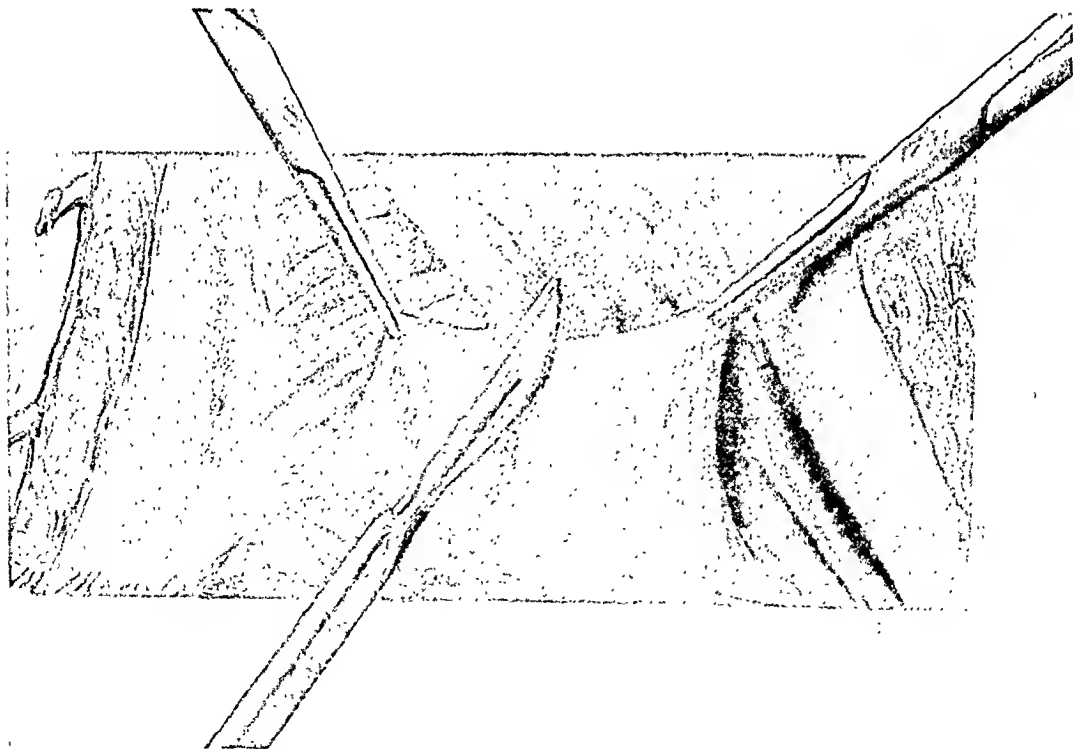


FIG. 2.—The division of the loose areolar tissue in the auscultatory triangle.

four are removed at one sitting. One can never predict just how much a tuberculous patient can tolerate, and it is a much wiser policy to stay well within the limit of safety in each of three stages of an operation than to be

on questionably dangerous ground in each of two stages. When the operation is broken up into many stages, or when it is thought that more than two weeks may elapse between operation, 10 per cent formalin solution or

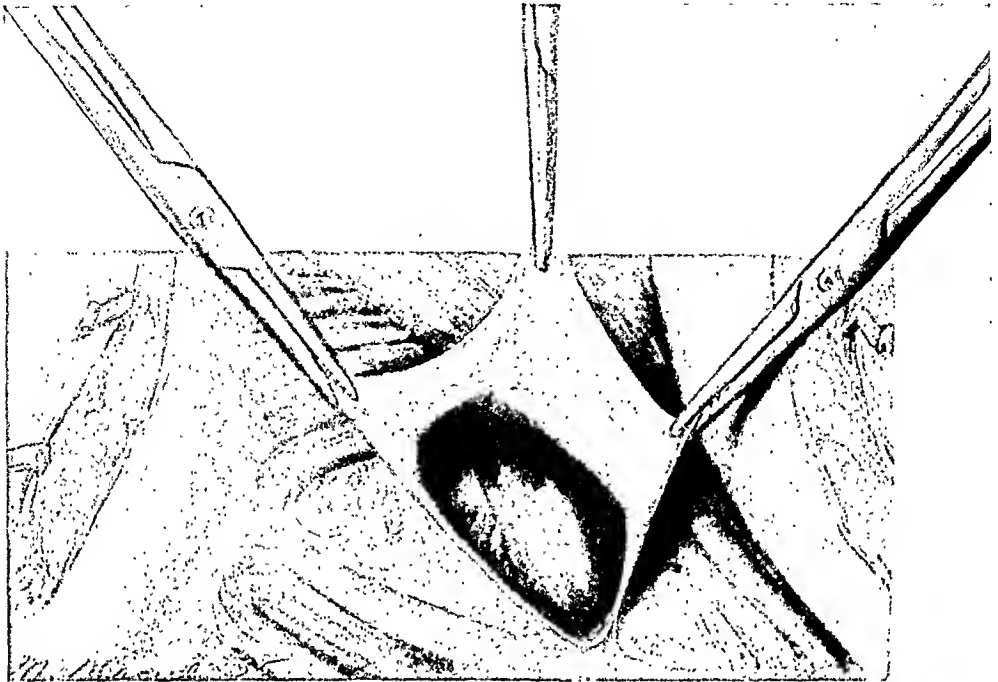


FIG. 3.—The arcular tissue in the auscultatory triangle has been divided and the cleavage plane between the sacrospinalis and overlying muscles exposed.



FIG. 4.—The latissimus dorsi muscle is being divided. Note the "tourniquet" effect of the thumb and forefinger on the left. On the right the muscle has been slightly released and a bleeding point thus rendered visible is being grasped with a hemostat.

Zenker's solution should be applied to the periosteum of the resected ribs. This prevents the regeneration of the ribs until the ultimate degree of collapse has been obtained.

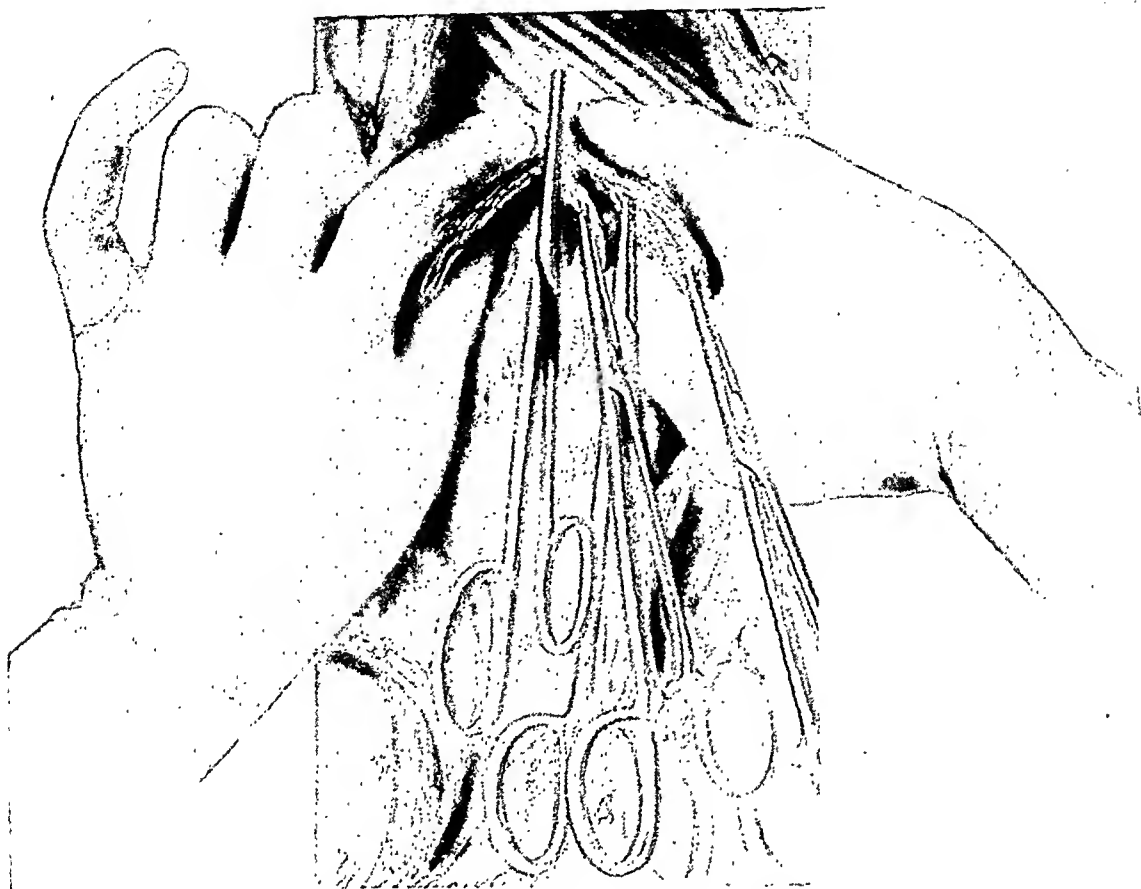


FIG. 5.—The division of the trapezius and rhomboids. The same maneuvers as in Fig. 4 are being carried out.

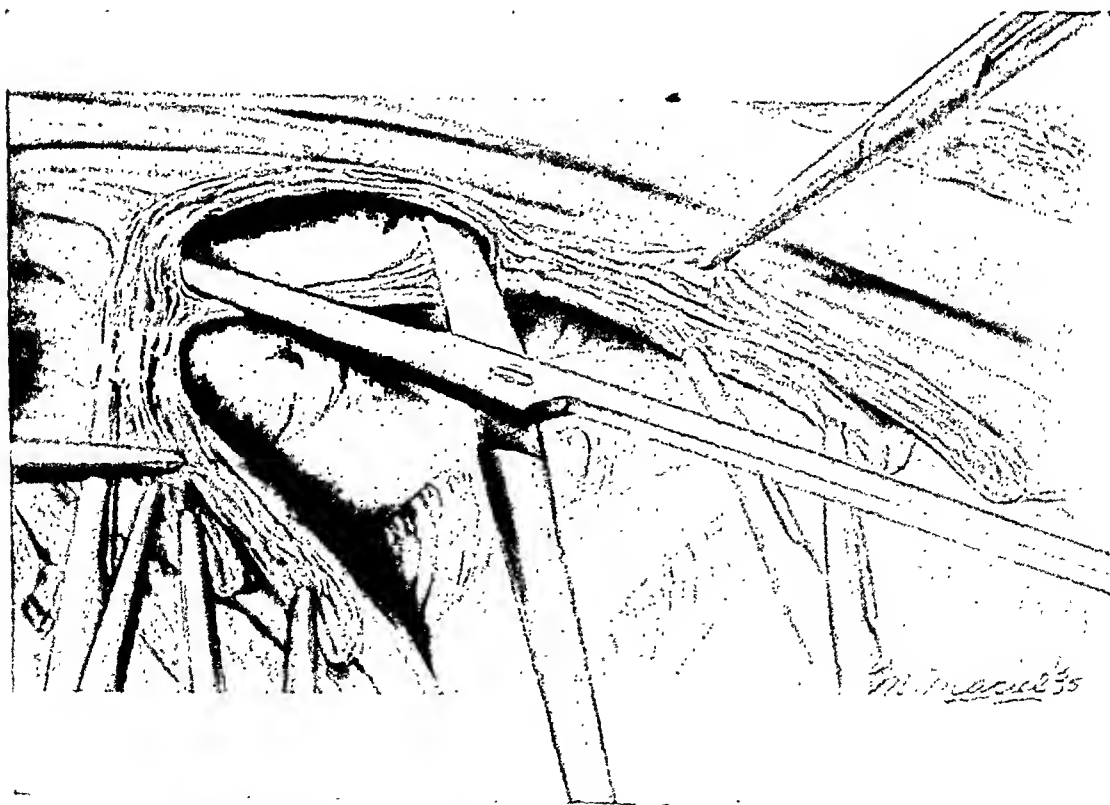


FIG. 6.—The separation of the trapezius muscle from the underlying rhomboid muscles.

It should always be borne in mind that the patients upon whom thoracoplasties are performed are potentially or actually poor risks and may easily be thrown into shock by loss of blood or by unnecessary traumatism to their tissues. In our clinic meticulous and gentle handling of tissues is insisted upon. Sharp dissection is done in contrast to the pulling and tearing of tissues; vessels are isolated where possible and divided between hemostats; cleavage planes are closely followed. Halsted hemostats are used exclusively, silk sutures and ligatures are used throughout the operation, and the wound is closed without drainage with interrupted sutures. All of our operations are performed under local anesthesia which, while more time-consuming and perhaps more trying on patient and surgeon, certainly tends toward more careful and gentle handling of tissues.

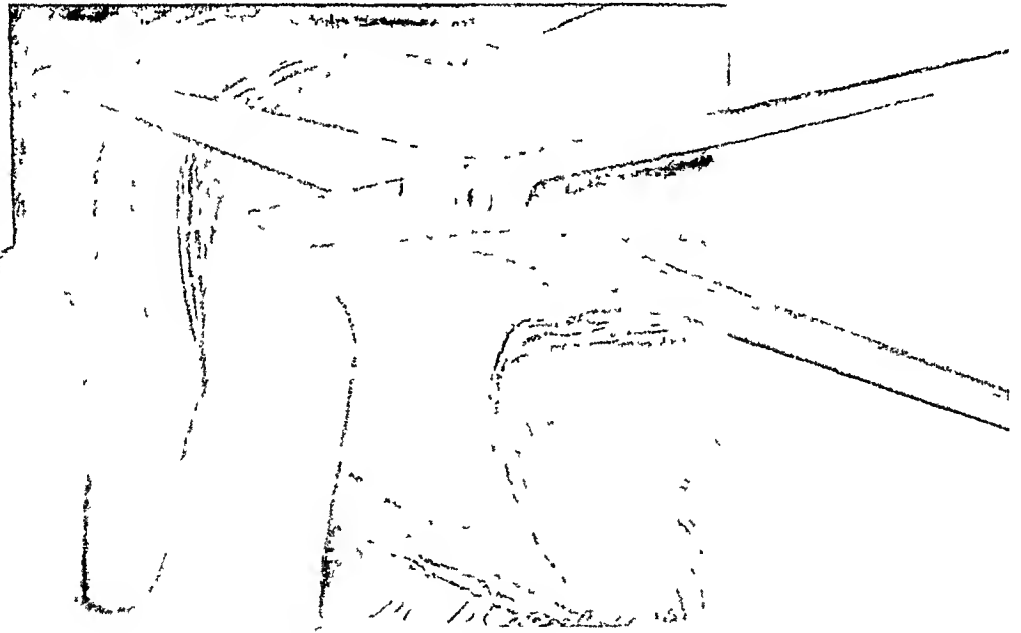


FIG 7.—The trapezius muscle has been separated from the rhomboids and is being divided. The underlying rhomboid muscles will be treated in the same manner.

A thoracoplasty is an operation of considerable magnitude, involving a very long incision with a wide exposure of raw surface. During its performance it is easy to lose more blood than one realizes, and loss of blood is a serious matter to the tuberculous patient who frequently has an anemia of some degree and in whom the general resistive powers are none too good. I make every effort to prevent loss of blood. The operation is carried out only as rapidly as is compatible with accurate hemostasis. All bleeding points are clamped, the larger vessels are ligated, the smaller ones are controlled with the Bovie unit. The steps in the operation which are necessary for an adequate exposure of the ribs and which carry with them the possibility of the loss of considerable blood are (a) the division of the heavy muscles of the back, *vis.*, the trapezius, the latissimus dorsi, and the rhomboids; (b) the

mobilization and retraction of the sacrospinalis muscle, and (c) the division of the serratus anterior muscle.

Two years ago I described a method by which the back muscles could be divided with little loss of blood. This consisted in dividing the loose areolar

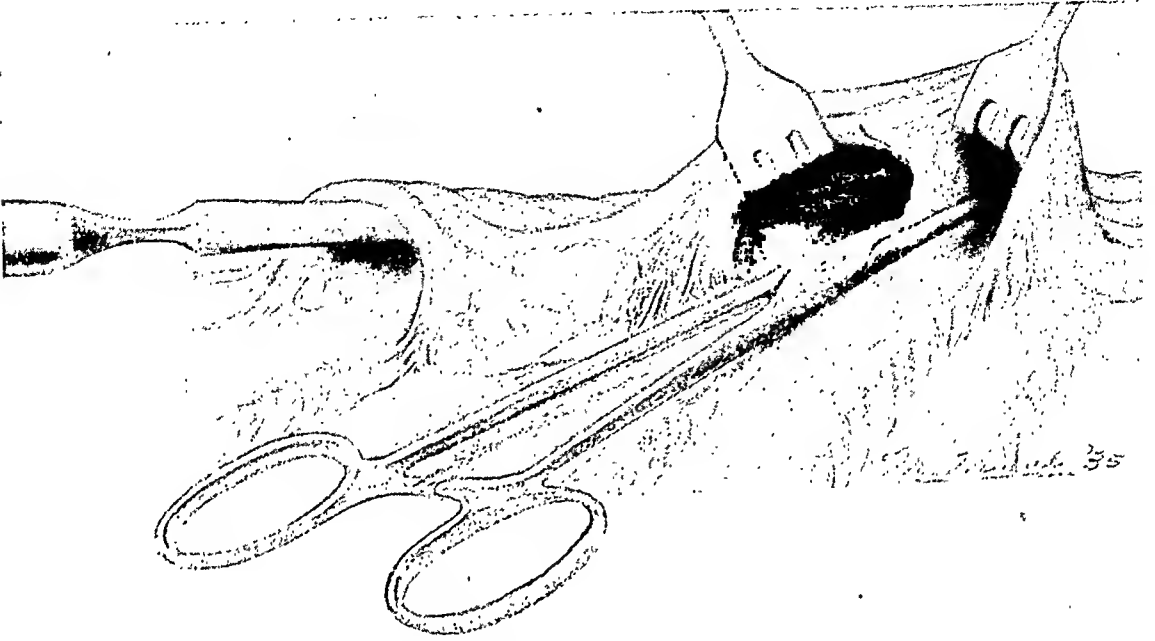


FIG. 8.—The mobilization of the sacrospinalis muscle.



FIG. 9.—The sacrospinalis muscle has been mobilized and retracted exposing the articulation of the rib with the transverse process.

tissue in the auscultatory triangle, in finding the cleavage plane between the sacrospinalis muscle and the overlying trapezius, rhomboids and latissimus, in freeing the latter muscles and in grasping them between thumb and finger

before dividing them. (Figs. 1, 2, 3, 4 and 5). By a slight release of pressure on the muscle the bleeding points can be seen and caught with hemostats before the vessels retract into the muscle. This method is still found to be satisfactory. It has been modified in that at the point where the trapezius muscle becomes quite thick, which is about opposite the fourth spinous process, it is separated from the underlying rhomboid muscle, then each muscle is divided individually, using the "tourniquet" method. (Figs. 6 and 7). This simplifies the procedure for when the muscles are thick it is difficult to compress them thoroughly. There is a large branch of the transverse cervical

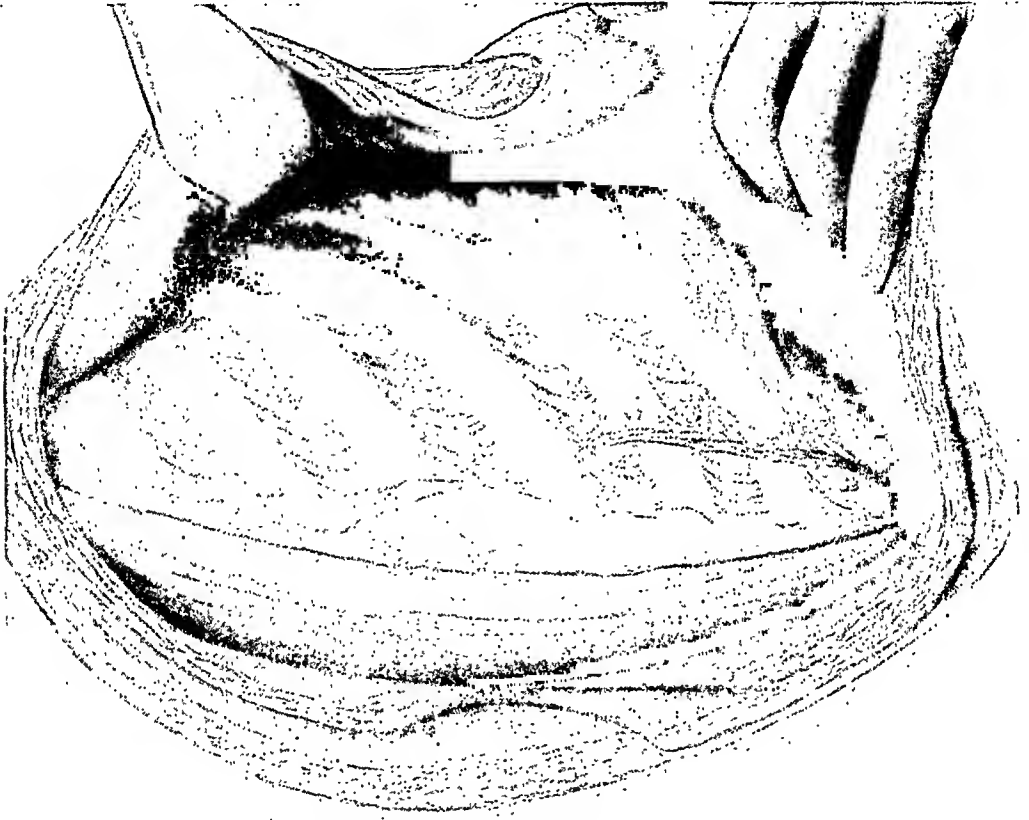


FIG. 10.—The scapula has been lifted, exposing the serratus anterior muscle.

artery which courses in the plane between these two muscles and is rather elusive unless it can be seen before it is divided. It is important to divide at one time only as much muscle as can be grasped, and to completely control the bleeding from its cut edge before proceeding with the grasping and division of the remainder of the muscle. The smaller vessels along the cut edges of the muscle are coagulated with the Bovie unit, but the larger ones are transfixed with fine silk.

The resection of the ribs close to the spine has always been essential in a properly performed thoracoplasty. However, within the past two years there has been a tendency to go farther still and to resect the transverse processes of the vertebrae also. The complete mobilization of the sacrospinalis muscle

is necessary in order to expose the articulations of the ribs with the transverse processes. (Figs. 8 and 9). A short incision is made at the outer edge of the muscle at the point where it crosses the rib. A narrow periosteal elevator is passed between the rib and the overlying muscle, hugging the rib and following it back to junction with the spine. This process is repeated on each of the ribs which are to be resected and on one or two ribs above and below them. Small retractors are hooked under the edge of the muscle where it has been freed from the ribs and the muscle is elevated. It will be found that the complete mobilization of the muscle is prevented by some fleshy



FIG. 11.—The serratus anterior muscle has been split up into several small portions.

fibers which attach it to the intercostal space. In each interspace there is a small artery which runs in these fibers and which supplies the sacrospinalis muscle. If these intercostal attachments of the sacrospinalis muscle are grasped with a hemostat before being divided, there is little loss of blood. After these intercostal attachments have been cut, it will be found that the muscle can be retracted medially so as to expose the transverse processes.

Experience has shown that it is essential to resect very long segments of the ribs overlying a cavity—this is in marked contrast to the procedure in the earlier thoracoplasties in which much shorter segments of the ribs were removed. Since practically every cavity is in the upper portion of the thorax, one is confronted with the necessity of gaining exposure of the entire lengths

of the upper ribs. When one attempts such an exposure he is confronted with the serratus anterior muscle which is attached to the upper six ribs along the posterior axillary line (Fig. 10) and, unless this muscle is divided, the portions of the ribs anterior to it cannot be reached. This muscle varies in size, but as a rule is at least one-half to one inch in thickness. Running in its substance are several large vessels. In addition, the axilla with all its structures lies just anterior to it. The problems in the division of the ser-



FIG. 12.—The lower portions of the serratus anterior muscle have been divided. The axillary contents are being pushed forward by the gauze sponge.



FIG. 13.—The serratus anterior muscle has been completely divided. Note the axillary vein, artery and brachial plexus as seen from the back, also the additional exposure of the ribs beyond the cut edge of the serratus muscle.

ratus anterior muscle are then to be able to control the bleeders in its substance, and not to injure the axillary contents which lie very close to it. These problems are met as follows: The scapula is elevated by deep retractors or an assistant's hand so as to put the serratus muscle on a stretch; starting below, at the level of the fifth or sixth rib, the muscle is split in the direction of its fibers with long handled scissors, just as one does the internal oblique muscle in making a McBurney incision (Fig. 11); other such splits are made

parallel to the first about one inch apart all the way up to the first rib. Thus the large muscle is divided up into many small bundles each of which can be divided and any vessel in it readily grasped with a hemostat. The lowermost bundle is divided first and the lower axilla entered from behind; a curved sponge stick grasping a small gauze sponge is now introduced through the opening in the muscle and the axillary contents gently pushed forward away

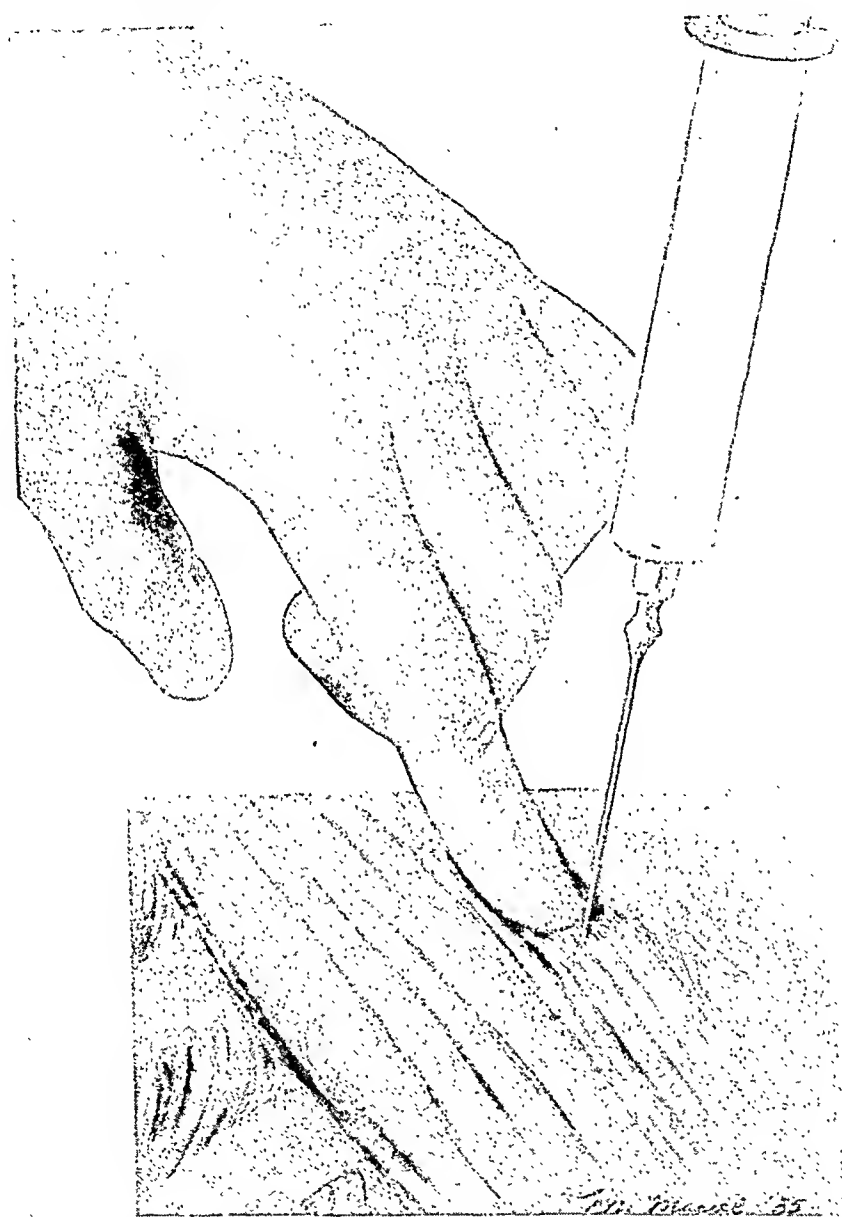


FIG. 14.—The injection of the intercostal spaces with $\frac{1}{2}$ per cent novocaine. Note that the injection is made close to the spine, the interspace being palpated through the sacrospinalis muscle.

from the muscle (Fig. 12). The individual muscle bundles are now divided with scissors. The densest attachments of the serratus anterior are to the first and second ribs and when these have been divided the scapula can be lifted far off the chest wall. After complete division of the serratus anterior muscle (Fig. 13) the axilla is clearly seen from the back, the axillary vein and artery and the brachial plexus are all identified, and the ribs can be followed around to their cartilages if desired.

As stated previously, all of our operations except a very few have been done under local anesthesia. Direct infiltration of the skin, subcutaneous tissue and muscles with $\frac{1}{4}$ per cent novocaine is done before the incision is made. When these structures have been divided and the intercostal spaces exposed, each space is injected with $\frac{1}{2}$ per cent novocaine close to the spine by palpating it through the sacrospinalis muscle (Fig. 14). The anesthesia is very satisfactory in practically all cases and it is most unusual for the patients to complain of pain, though sometimes the retraction of the scapula gives discomfort as does the freeing of the first rib. The safety of having the patient's cough reflexes present and the fact of not being fearful of a long inhalation anesthesia more than outweigh the somewhat greater tediousness of the operation under local anesthesia.

The wound is carefully inspected before closure to be sure that all bleeding points have been controlled. The muscles are closed accurately with interrupted sutures of silk, as is the skin. None of the cases has been drained. Subsequent stages are done at two week intervals or as nearly so as possible.

DISCUSSION OF THE PAPERS OF DOCTORS JOHNS AND CARTER

DR. FRANK H. LAHEY (Boston, Mass.).—I do not wish to pose as a thoracic surgeon. I say this not boastfully but regretfully, because this work is so stimulating. I think that any group that has had any experience with chest surgery should take occasion to present their conclusions and results, for in this field, which is making so much progress, it is necessary to present figures which will be interesting and stimulating to everyone involved.

As to bronchiectasis, Doctor Overholt, who does the chest surgery in our Clinic, has done eight lobectomies. He feels that one should make no decision as to one or two stage procedures before deciding as to whether or not there are adhesions between the pleura and the lobe, but when there are adhesions the operation may be done in one stage. When done in two stages, it is of great advantage, he feels, first for the chest surgeon to cut the inferior pulmonary ligament which permits the lower lobe to contract and then the upper lobe to expand and fill the cavity. He has performed lobectomy in eight cases with no operative deaths and all in good health at present. Some are not completely free of cough and expectoration, but they are greatly improved. Five were done in one stage and three in two stages. He has, at the present time, completed a two stage lobectomy on the right side in one individual and the first stage of a left lower lobectomy in the same individual.

Everyone who is performing thoracoplasty is indebted to Doctors Cole and Johns for establishing the use of the procedure from above downward. Just as in subtotal thyroidectomies, these patients need time to recover from the first stage of the operation. They need a time to be up and around. If you make roentgenograms within two weeks the lungs are still cloudy. If you do the operation at the end of two months, the patients are strong and in good condition, and it is easier to perform the secondary procedure. Our chest surgeons strongly believe that the period of time between stages of the thoracoplasty operation should be somewhere between four and eight weeks. There must be an optimum time and it cannot be within a period of ten days to two weeks. As a general surgical principle, we do not feel that patients should be subjected to a second major operation until after they have obtained all possible benefits from the first procedure. In view of the fact that rapid

successive stage operations in thoracoplasty work is preached, and carried out, in so many places in this country, it is the feeling of our men that it is very important to emphasize the necessity of this delay in the second stage operation.

Our chest service is accepting bilateral cases for thoracoplasty if there is at least one functioning lobe on each side, and if the vital capacity is not under 1,100 cc. Doctor Overholt and his associates have done 575 thoracoplasties in 250 patients in the Clinic with an operative mortality of 2 per cent and a patient mortality of 4 per cent. In a recent analysis of the first 100 patients operated upon, the following results have been obtained: Improved, 88 per cent; unimproved, 1 per cent; operative deaths, 4; sanatorium deaths, 7; apparently arrested cases, 66. (Of these 36 have been discharged from the sanatorium.) Approximately 20 bilateral cases were included in this first series of 100 patients.

As to primary carcinoma of the lung, here I think is another exceedingly stimulating field. Eighty per cent of the cases upon whom Doctor Overholt has operated had lesions in the stem bronchus which were visible through the bronchoscope. There is today an increasing tendency to make roentgenograms of patients, with obscure chest symptoms, and interpretation of chest films has improved. Bronchoscopy is being carried out more frequently than formerly. The value of diagnostic pneumothorax and intrapleural thoracoscopic examination is recognized, and the use of aspiration biopsy will assist in the diagnosis of obscure peripheral lung tumors. When one realizes that there is a tendency for these primary growths of the bronchus to be relatively benign, and that the carcinoma is surrounded by cartilage which tends to protect it from extension, this becomes a relatively hopeful field.

We are more and more impressed with the value of cyclopropane, and we believe that all intrathoracic operations should be carried out under intratracheal anesthesia, preferably with this agent. We routinely use oxygen therapy for the first two or three days following operation.

Doctor Overholt has carried out two lobectomies for malignancy of the lung. Both patients recovered; one lived ten months and died of mediastinal metastases. The other patient, who had a right upper and middle lobe resection, is living at present without evidence of metastasis. He has carried out six total pneumonectomies for malignant disease, with three operative recoveries, and all of these patients are living, one 25 months, one 19 months, and another nine months, all without evidence of recurrence. In addition to the six pneumonectomies for malignant disease, he has done two successful total pneumonectomies for suppurative disease of the lung. We have recently received letters from 12 men in this country who have been doing most of the work of this kind and have summarized their results together with those cases reported in the literature, and find that up to 1933 four pneumonectomies for malignancy of the lung were attempted—all operative deaths. We find that since 1933 there have been 34 pneumonectomies attempted and completed with operative recoveries in 18 and of these 18 ten patients are still living. It is also interesting to report that 12 of these 34 pneumonectomy cases were done in Boston, six by Doctor Churchill and six by Doctor Overholt. Doctor Churchill had four recoveries and we have had three operative recoveries. However, two of Doctor Churchill's patients have since died of metastases so that there are five of the ten living pneumonectomy cases done in Boston, two by Doctor Churchill and three by Doctor Overholt.

When we realize that previous to the establishment of the Department of Chest Surgery in our Clinic we had made the diagnosis once of primary carcinoma of the lung and that in the past four years we have made the

diagnosis 33 times, it becomes evident how many cases are being overlooked. The outstanding feature has been intractable cough. When one realizes that it produces atelectasis early, that this is recognizable by roentgenologic examination, and that 80 per cent can be recognized by the bronchoscope, one realizes that this is a field which offers really great promise.

DR. W. P. HERBERT (Asheville, N. C.) (guest).—We have found in a number of cases of arrested tuberculosis that there is what one might call a bronchiectatic state existing in them, in either one or both lungs. Not a true bronchiectasis but one which causes considerable discomfort to the patient and is the source of some irritation. Two years ago I reported two cases operated upon for this condition. Since that time there have been two more. The operation as described consisted in removing the rib above the lesion thus making a gutter so that dense adhesions could form with the pleura. In this way one gets more or less fixation of the lung. Following this a resection of the ribs over the bronchiectatic area is performed. This in turn is followed by a phrenicectomy. Thus a collapse of that portion of the lung which is causing the trouble is effected. As I have said before, I do not advocate this in a massive bronchiectasis, but I feel that in some instances this procedure is of value.

DR. FRANK S. JOHNS (closing).—We have not felt that it was necessary or wise to remove the entire upper third and fourth ribs in all of our cases. If we have a large cavity and we think it is essential to remove the entire rib or ribs to close this cavity, we do so. For smaller cavities we remove shorter lengths of the ribs.

Doctor Lahey is correct in emphasizing the importance of ample time between the stages of selective collapse for pulmonary tuberculosis. These cases should be given an opportunity to get the full benefit of the previous stage of the operation.

THE SURGICAL TREATMENT OF CONGENITAL TRACHEO-ESOPHAGEAL FISTULA IN THE NEW-BORN

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CONGENITAL malformations of the esophagus are of various types, but fortunately these anomalies are not common. They occur, however, with a greater frequency than is commonly thought, as evidenced by our experience, having seen six cases during 15 months. Brenneman¹ reports the observation of five cases in five years. We believe that as one becomes familiar with the clinical manifestations of these lesions, the incidence will increase. There is no doubt that a large number of cases that supposedly die of birth injuries, especially in those with cyanosis, atelectasis, or postdelivery pneumonia, are cases of undiagnosed congenital tracheo-esophageal fistula.

Although tracheo-esophageal fistulae are the most frequent congenital anomalies of the esophagus, there are many other embryologic defects. Strong and Cummings² suggest the following classification of esophageal anomalies:

- (A) Involvement of the entire passage
 - (1) Stenosis
 - (2) Total atresia (reduced throughout to a solid cord)
 - (3) Agenesis (no detectable vestige of the structure)
 - (4) Doubling of the whole length of the passage.
- (B) Regional involvements
 - (1) Stenosis (single or multiple stenotic intervals)
 - (2) Atresia (either by the narrowing of an interval or by the presence of a barrier fold, or membrane in an esophagus otherwise normal)
 - (3) Agenesis (no detectable remnant of a restricted interval)
 - (4) Fistula communicating with trachea or a primary bronchus
 - (a) Esophagus otherwise normal
 - (b) Esophagus divided into upper and lower segment by a regional stenosis, atresia or agenesis, the fistula being usually single and uniting the lower segment with the trachea
 - (5) Doubling in a short extent
 - (6) Diverticula
 - (7) Cysts

The Group B.4b anomalies are the most frequently encountered. It is these that will be considered in the present discussion. The lesion consists of stenosis, atresia, or agenesis of the esophagus, usually the formation of

a blind pouch at the distal end of its proximal segment and a fistula between the trachea and the distal esophageal segment.

According to Mackenzie,³ the first recorded case was by Durston, in 1670. He reviewed 62 cases of malformations of the esophagus, of which group 40 (66.1 per cent) had atresia, with the lower end of the esophagus joining the trachea just proximal to the bifurcation. Plass,⁴ in 1919, reported a review of 136 collected cases of esophageal atresia with tracheo-esophageal fistulae. In 1926, Hacker and Lotheissen⁵ reported 223 cases of malformation of the esophagus, of which 173 (77 per cent) had a communication between the lower segment of the esophagus and the trachea. In 1931, Rosenthal⁶ reported 255 cases of congenital esophageal atresia. In 215 (84.4 per cent) there were tracheo-esophageal fistulae. From the above statistics it is evident that the most frequent congenital malformation of the esophagus is an atresia with a tracheo-esophageal fistula. The most common type is that in which there is a segmental agenesis resulting in the formation of a blind esophageal pouch at the distal end of the upper segment and a fistula between the lower end of the trachea and the proximal end of the distal segment of the esophagus which is otherwise normal.

The genesis of this unusual anomaly is explained by a number of theories, some of which are fanciful, while others certainly are based on embryologic dysfunctions that are responsible in part or in whole for the formation of tracheo-esophageal fistulae.

The esophagus and trachea are developed from the primitive foregut. In the young embryo (3 Mm. to 4 Mm.) they are one tube which subsequently becomes divided by the tracheo-esophageal septum derived from a longitudinal projection from each lateral wall, which meet in the midportion of the primitive foregut (Fig. 1). Early in the development the trachea is only partially separated from the esophagus. The anomalous development of this septum that separates the trachea from the esophagus, forming two distinct tubes, is responsible for tracheo-esophageal fistulae. The lung bud anlage is the ventral outgrowth from the primitive foregut at the site of the future tracheal bifurcation, disturbances in the development of which may account for incomplete septal closures in the distal portion.

Luschka⁷ and Klebs⁸ believe that intra-uterine fetal infection or trauma are responsible for these defects. It has been suggested that normally in the development of the esophagus its lumen is patent up to approximately five weeks. Following this, however, the esophageal lumen becomes obliterated as the result of excessive epithelial proliferation, the lumen subsequently being reestablished by a process of vacuolization. Kreuter⁹ suggests esophageal atresia results when vacuolization does not occur. Schridde,¹⁰ however, in the study of 50 human embryos, found a normal lumen in the esophagus at all stages. Forssner¹¹ demonstrated that the separation of the trachea from the esophagus occurred at an early stage (4 Mm. to 5 Mm. embryo), whereas the epithelial obliteration of the lumen of the esophagus does not occur until the embryo is 20 Mm. in length. Streeter¹² and Rosen-

thal⁶ suggest that there is a great similarity between the two developmental anomalies, spina bifida and tracheo-esophageal fistula. The latter author states in his conclusions: "The development of the anomaly seems to rest on an early fundamental change in the entodermal cells that are to give rise to the esophagus, and not on primary concomitant abnormalities. This change may be genetic and related to the anterior end of the neurenteric canal." Strong and Cummings² state that "the agencies predisposing to the anomaly are to be sought either in the reproductive cells from which the child was produced or in an unfavorable intra-uterine environment obtaining during the critical early period of embryonic life." They believe it is entirely a growth deficiency occurring in the two lateral intraluminal entodermal projections, the anlage of the tracheo-esophageal septum. According to Lateiner,¹³ there is in addition to the lateral mesenchymal ridges which divide

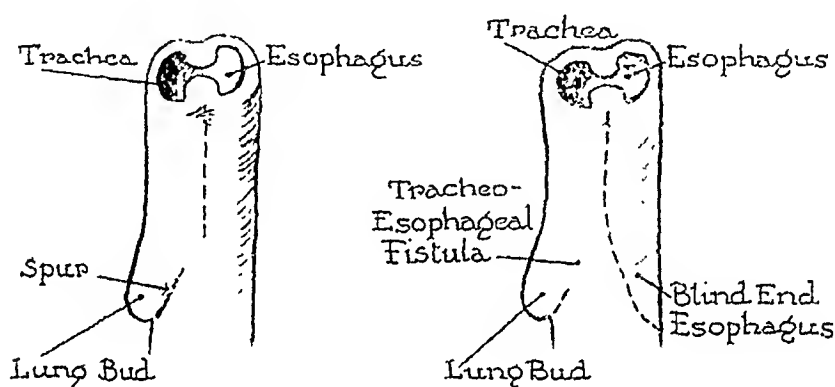


FIG. 1.—Drawing showing the spur formation of the lung bud which normally meets with the two mesenchymal ridges, separating esophagus from trachea. It is failure of this spur to meet the two lateral mesenchymal ridges which causes the spur to attach itself to the posterior wall of the esophagus, thus creating an esophageal atresia and agenesis with tracheo-esophageal fistula. (After Lateiner¹³.)

the foregut into the trachea and esophagus a spur formation from the lung bud anlage, which spur grows upward into the foregut, meeting the two lateral ridges. He believes that when there is failure of the spur to join the lateral ridges and a fusion of the septum with the posterior wall of the foregut, the typical lesion results; *i.e.*, atresia of the proximal esophageal segment and fistulous communication between the trachea and the distal esophageal segment (Fig. 1). This abnormality is also dependent upon growth deficiency and the entire abnormal process may be expressed by Rienhoff's¹⁴ law: "There is in the life cycle of a cell or tissue, which is differentiating or growing, a period in which the cell is very sensitive to its environment and any injury of it at this stage will result in the abnormal growth and development of that cell or structure." We ascribe to the theory of Lateiner¹³ as being the most plausible. For a more detailed description of the different theories, the reader is referred to the excellent papers of Plass,⁴ Hacker and Lotheissen,⁵ Rosenthal,⁶ and Strong and Cummings.²

The gross pathologic picture is remarkably constant in cases seen at

autopsy. In over 80 per cent of the cases there is an atresia with agenesis of the esophagus, dividing the esophagus into two distinct parts with an upper segment which terminates in a blind pouch about 10 to 12 cm. from the alveolar region. The pharyngeal part of the upper segment is normal. The end of the proximal segment is on the average 3.4 cm. below the larynx (Plass⁴). The distal esophageal segment, as a rule, is normal except at its proximal end where it is narrow and forms a fistulous communication with the trachea and rarely with one of the main primary bronchi (usually the right). The average distance of the fistulous opening above the bifurcation of the trachea is 0.5 cm. (Plass⁴ and Rosenthal⁶). In most cases the upper blind pouch is entirely separated from the lower segment (agenesia), but occasionally there may be a fibrous cord or muscle band connecting the distal limb of the upper segment to the proximal end of the lower segment (Fig. 5). The tracheo-esophageal fistula is situated just proximal to the bifurcation and consists of a small, slitlike opening, resembling the mouth of a small bronchus (Fig. 8). Bronchoscopically, the fistula appears as the opening of a bronchus. The fistula is so formed that above it the posterior wall of the trachea is depressed, forming a gutter extending down to the fistula, the lower edge of which extends into the lumen of the trachea, producing a valve trap. This results in deviation of secretions and fluids from the trachea into the fistula.

The lungs reveal varying degrees of pneumonia and atelectasis due invariably to the aspiration of fluids and food into the tracheobronchial tree from an esophageal overflow. There is a high incidence of concomitant congenital abnormalities of other organs (Kelly,¹⁵ 60 per cent; Hacker and Lotheissen,⁵ 38 per cent; and Plass,⁴ 62 per cent). The most common associated anomalies are (1) those in the lower rectum and anus, atresia and being the most common (Plass,⁴ 25.5 per cent), and (2) those in the genito-urinary tract; *i.e.*, horse-shoe kidney, unilateral kidney, double and single ureters with and without stricture. Atresia duodeni, harelip, and other anomalies are rare. However, the majority of associated anomalies are not incompatible with life, and, therefore, they in themselves are no contra-indication to the treatment of tracheo-esophageal fistula.

The symptomatology of esophageal atresia and tracheo-esophageal fistula is so constant that the lesion should be easily recognized. The symptoms can be divided into two main groups: (1) gastro-intestinal, and (2) pulmonary. The infant at birth is well developed and appears normal except for an excessive amount of mucus in the mouth, which is probably due to its accumulation in the blind esophageal pouch and emptying into the pharynx. At times the secretion is so abundant that it interferes with breathing and attacks of cyanosis occur. These symptoms result from filling and emptying of the blind pouch of the proximal segment of the esophagus. The abdomen rapidly becomes distended by the ingress of large quantities of air from the trachea through the fistula into the stomach and small intestine. This is determined both clinically and by roentgenograms (Figs. 3, and 7). The most classic

symptoms are referable to the pulmonary system and occur dramatically at each feeding. At the first attempts at feeding, nothing happens for a few seconds, but soon a definite train of events occur. There is a cough, fluid which is often frothy regurgitates through mouth and nose, and early cyanosis occurs, and more fluid is projected through the nose and mouth as the blind pouch of the esophagus and bronchial tree is emptied of its fluid and food. Almost lifeless relaxation occurs, the cyanosis disappears, and the infant recovers to go through the identical process at the next feeding. It is simply a picture of pulmonary aspiration of fluids which may produce drowning at the first feeding, or, as more often happens, in a few days the infant succumbs to an aspiration pneumonia. These symptoms are due to emptying by reverse peristalsis of the contents of the filled blind esophageal pouch into the hypopharynx and the subsequent spilling into the trachea, some of the fluid passing into the lower segment, then into the stomach by way of the tracheo-esophageal fistula. However, most of the fluid enters the tracheobronchial tree, resulting in suffocation and occasionally death. There naturally follow rapid loss in weight and dehydration due to inability to take fluids and nourishment.

The diagnosis is not difficult if the condition is only considered. However, the majority of cases are never diagnosed until the typical symptoms appear at the first feeding, which is undesirable because the hopelessness of these cases in the past has been due to the early onset of aspiration pneumonia. We believe that the diagnosis should be made at birth. A catheter should be passed gently into the esophagus routinely in all new-borns. In this way a diagnosis can be made before there is any aspiration of the mouth secretions. If a new-born has an excessive flow of mucus from the mouth and the abdomen becomes rapidly distended (a valuable diagnostic sign, according to Brenemann,¹) the upper esophagus should be immediately investigated. In such cases, we suggest that a catheter be passed into the esophagus and if an obstruction is met one can almost with certainty diagnose the presence of an esophageal atresia. If the catheter meets an obstruction from 10 to 12 cm. from the alveolar ridge then lipiodol should be injected into the esophagus and a roentgenogram taken. This should include the thorax and abdomen. If esophageal atresia and tracheo-esophageal fistula are present, the blind pouch is outlined by the lipiodol. There is usually some spilling of lipiodol into the trachea and lung; and the stomach and small intestine will be filled with gas (Fig. 3). We cannot overemphasize the necessity of using lipiodol instead of barium, as the latter is contraindicated due to its irritating action on the lung parenchyma. If this routine as suggested is followed, then, and not until then, will the surgeon secure the infant free of pulmonary complications.

The treatment of this unfortunate anomaly is entirely surgical. The ideal operation would be the separation of the esophagus from the trachea and an end-to-end anastomosis of the upper to the lower segment. Such an extensive intrathoracic procedure is not justified in a new-born infant, however, and the operation would always be finished as a postmortem procedure. There are two definite surgical indications: (1) closure of the fistula, and

(2) an avenue (gastrostomy) through which the infant can be nourished. Richter,¹⁶ in 1913, suggested and performed the first intrathoracic ligation of the proximal end of the distal segment of the esophagus to close the fistula. He reported two cases that terminated unsuccessfully. We believe that this transpleural ligation is too formidable for an infant two to three days old, and have not used the procedure. We believe that the simplest procedure should be used. Therefore, we recommend intra-abdominal ligation of the cardiac end of the esophagus with umbilical tape to prevent regurgitation into the lung of gastric contents through the tracheo-esophageal fistula, and the formation of a gastrostomy of the Ssabanejew-Frank¹⁷ type.

The technic of the operative procedure is as follows: Through an upper left rectus paramedian incision the peritoneum is opened and the stomach

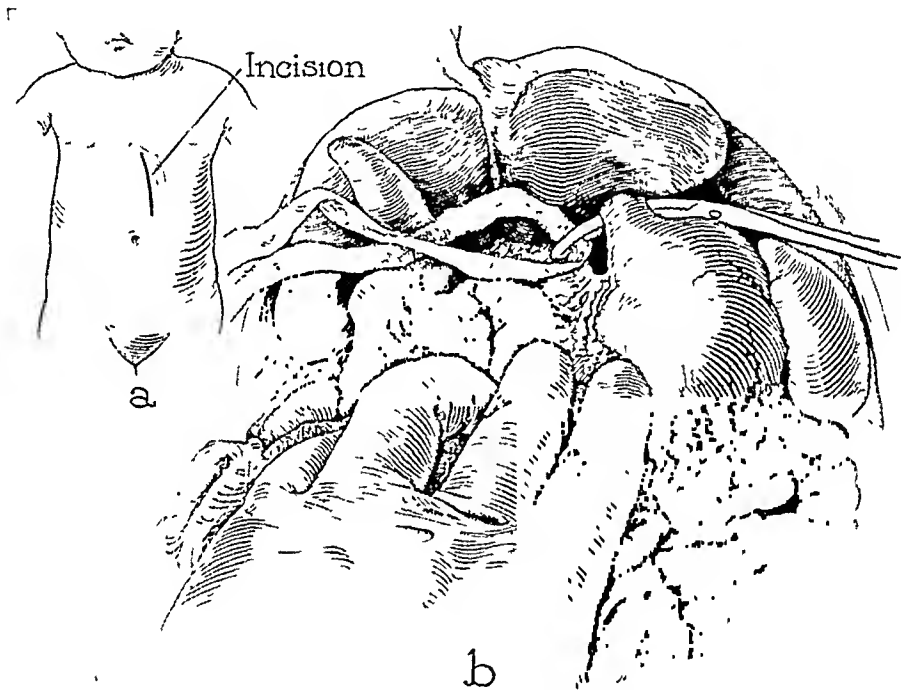


FIG. 2.—Drawing demonstrating the left rectus incision and the method of adjusting the umbilical tape ligature around the cardiac end of the esophagus.

grasped gently by “gauze covered fingers” of the left hand and retracted downward. The left lobe of the liver is elevated upward out of the field by a moist gauze covered retractor. The stomach is then depressed downward and backward. This brings the cardiac end of the esophagus to view just beneath the diaphragm (Fig. 2). A right handed aneurysm needle threaded with catgut is gently passed around the esophagus, the catgut grasped and tied to a ligature of umbilical tape. The needle is left *in situ*; the catgut is removed from right to left, pulling the tape behind the esophagus. This tape ligature is gently but firmly tied, which obliterates the lumen of the esophagus. A curved forcep can be used to pass behind the esophagus and pull the ligature of tape around the esophagus (Fig. 2). However, we recommend the aneurysm needle, as the procedure can be accomplished with

greater rapidity. The vagi are incorporated in this ligature. This cannot be avoided, but we feel that there will result slight if any deviation from the normal physiologic activity of the gastro-intestinal tract.

A gastrostomy is now formed according to the technic of Ssabanejew-Frank as follows: The stomach is grasped with Allis forceps near the greater curvature close to the cardia and by pulling on the Allis forceps a pouch of the anterior gastric wall is formed. This pouch is now pulled under, or over the rectus muscle through a tunnel in the tissues, making its exit through a secondary incision about 3 cm. from the left rectus incision. The pouch is attached to the skin of the secondary incision and the left rectus incision is closed with silk. The tip of the pouch is now cut off and a catheter can be passed easily into the stomach. The advantages of this form of gastrostomy are many: the procedure is rapidly performed, there is a tube lined with epithelium which prevents stricture of opening, and with pressure over the tunnel through which the pouch passes spilling of gastric contents between feedings does not occur. We believe these two procedures are the simplest that can be performed and yet accomplish the desired results, and both should not take over 20 to 25 minutes in their execution.

The postoperative treatment consists of administering fluids and food by the gastrostomy. Fluids should also be given by hypodermoclysis. The upper blind pouch of the esophagus should be aspirated frequently to prevent overflow into the trachea. If this simple procedure is not done aspiration pneumonia may result. The lower blind pouch created by the operation will probably take care of itself for a while, but will ultimately have to be treated by the intratracheal route. We believe that as soon as possible the upper segment should be removed to the outside of the neck as a preliminary to a future plastic operation to form an anterior thoracic esophagus. The lower segment as well as the fistula opening must be obliterated to prevent infection, because this infected material will be aspirated up into the tracheobronchial tree, producing a pneumonitis.

For a successful outcome in these cases the emergency treatment as well as the future formation of a new esophagus depends entirely upon the cooperation of the obstetricians, pediatricians, surgeons, thoracic surgeons, and the bronchoscopists. It is by the combined efforts of the above named specialists that the present mortality of 100 per cent should decline rapidly to a lower level and a few lives may be saved.

CASE REPORTS

Case 1.—Premature white male, born October 22, 1935, at 1:45 A.M. The infant cried immediately after delivery. However, respirations soon became difficult and cyanosis occurred. Cyanosis and difficult respirations were promptly relieved by aspirating mucus from the hypopharynx. These attacks recurred at frequent intervals and were relieved by removal of the excessive mucous secretions. The infant was put to the breast every two hours beginning at 10:00 A.M. the date of birth. It was noted that all attempts at nursing resulted in regurgitation of food through both the mouth and the nose. The infant struggled for air, cyanosis rapidly appeared, and it seemed that death would supervene. However, the

infant finally started breathing normally and the cyanosis disappeared. Due to the repeated attacks of cyanosis the infant was put in the Drinker respirator.

A catheter was passed into the esophagus where it met with an obstruction about 12 cm. from the alveolar margin. Lipiodol was introduced into the upper end of the esophagus and a roentgenogram was made. This revealed a blind esophageal pouch of the upper segment of the esophagus. The stomach and the small intestine were filled with gas (Fig. 3). A diagnosis of esophageal atresia with agenesia and tracheo-esophageal fistula was made.



FIG. 3.—Roentgenogram of thorax and abdomen after the esophagus had been injected with lipiodol. The blind pouch of the esophagus is well defined, and the typical gaseous distention of the stomach and small intestine is well depicted (Case 1).

Operation.—Through a high paramedian left rectus incision the cardiac end of the esophagus was ligated with umbilical tape. A simple gastrostomy was performed by the technic of Kaader (Fig. 5). The infant was returned to the Drinker respirator where it remained until October 25 when it died from an aspiration pneumonia.

Autopsy Findings.—Esophageal atresia with agenesia and tracheo-esophageal fistula; bilateral aspiration pneumonia. The following associated congenital anomalies were present: Right kidney replaced by a large cyst; right ureter had a stricture at its lower end (Figs. 4, 5 and 6).

Case 2.—White female infant, born July 6, 1935, full term, weight 6.5 lbs. Physical examination revealed a normal female infant without any external evidence of congenital malformations. The infant continued to react normally until the first feeding, at which



FIG. 4.—Photograph showing the entire viscera (Case 1). The blind pouch of the upper segment of the esophagus is well shown. The lower segment of the esophagus with ligature attached is seen beneath the liver. The gastrostomy tube is shown protruding from the anterior stomach wall.

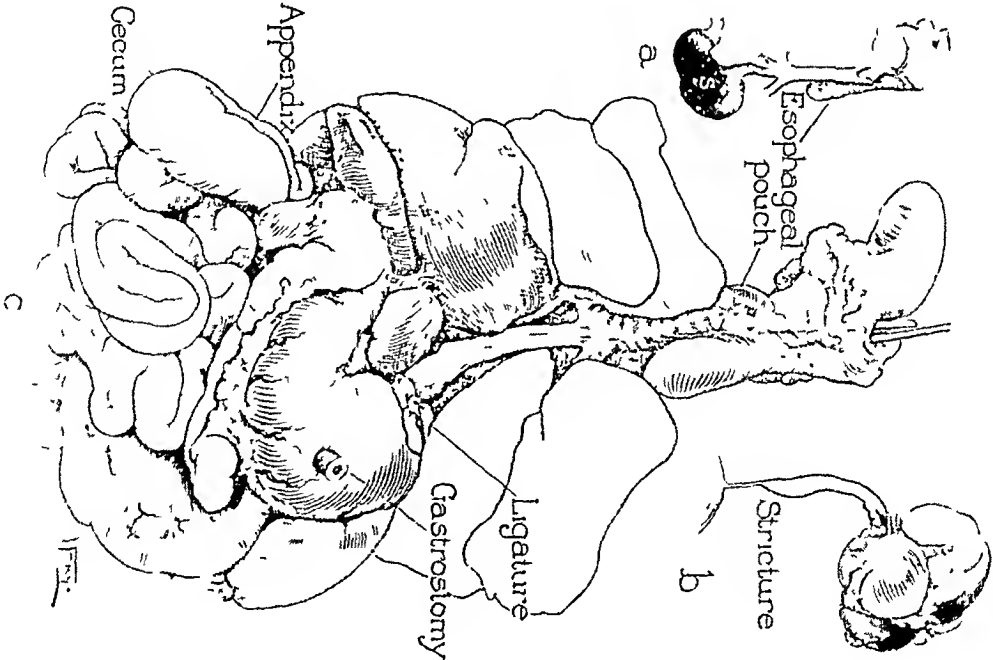


FIG. 5.—Drawing of the gross specimen shown in Fig. 4. The drawing shows: (a) the blind pouch of the esophagus and the tracheo-esophageal fistula; (b) the cyst of the right kidney and the stricture of the lower part of the right ureter; and (c) the anatomic relationships of the entire congenital anomaly with the ligature of umbilical tape around the cardiac end of the lower segment of the esophagus. The gastrostomy tube is seen projecting from the anterior wall of the stomach.

time she took fluid for a few seconds, which was soon regurgitated through both the mouth and the nose. Cyanosis occurred, the infant gasped for breath, the fluid ceased flowing from the nose and the mouth, the cyanosis disappeared, and the infant again appeared normal. This train of clinical signs and symptoms occurred at each feeding.

The infant was admitted to the Touro Infirmary on July 31, 1935, at 12:35 A. M. Examination at this time revealed an infant four days old who was apparently normal with the exception of a slight dehydration and elevation of the rectal temperature to 102° F.



FIG 6—Roentgenogram of thoracic and abdominal viscera removed from Case 1, after the injection of barium into the trachea. The lungs, tracheo-esophageal fistula, trachea, esophagus, upper and lower segments, and stomach are visualized.

From the history a tentative diagnosis of esophageal atresia and tracheo-esophageal fistula was made. A small catheter was introduced into the esophagus where it encountered an obstruction about 12 cm from the alveolar margin. Lipiodol was instilled through the catheter into the esophagus and a roentgenogram was made. This revealed a typical complete esophageal atresia and agenesis of the upper segment. Tracheo-esophageal fistula was also inferred because the stomach and small intestine were filled with gas (Fig. 7).

Operation.—July 31, 1935, under ether anesthesia the cardiac end of the esophagus

TRACHEO-ESOPHAGEAL FISTULA

was ligated through a high left rectus paramedian incision. A gastrostomy was also performed by the technic of Ssabanejew-Frank.

The infant reacted well from the operation and was given fluids at regular intervals through the gastrostomy tube. On August 1, the infant suddenly became cyanotic and had great difficulty in breathing. The temperature was elevated to 102.8° F. Cyanosis and difficult respirations continued and the infant succumbed at 3:00 A.M. August 2, 1935.



FIG. 7.—Roentgenogram of the thorax and abdomen (Case 2), showing the typical blind pouch of the upper segment of the esophagus in the upper thorax. The typical gaseous distention of both the stomach and the small intestine, so characteristic of tracheo esophageal fistula, is well outlined.



FIG. 8.—Photograph of viscera removed from Case 2, showing tracheo-esophageal fistula opening just above the bifurcation of the trachea. The opening is opposite the point of the white marker.

Autopsy Findings.—Esophageal atresia with agenesis and a tracheo-esophageal fistula with the opening just above the bifurcation of the trachea (Fig. 8). The lungs revealed a bilateral aspiration pneumonia of both upper lobes. A horse-shoe kidney was an associated congenital anomaly.

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DISCUSSION.—DR. URBAN MAES (New Orleans, La.).—I think I can add a small bit of encouragement to the very depressing report Doctor Gage has made, and at least point out a mistake that should not be made. These children usually come to the surgeon only after they have been given barium for roentgenologic examination, which is a serious and usually fatal error. I was discussing the subject a few weeks ago with Doctor Scott of the University of Rochester, and his experience parallels my own in the three cases I have seen personally—that all the children have pneumonia, and that the lung picture always shows a tiny fleck of barium in the center of each patch of pneumonia.

The diagnosis ought to be made in some other way. Usually the clinical history and physical findings are clear, and if they are not, and some visualization is necessary, the use of lipodol is less harmful than the use of barium.

Doctor Scott informed me that one of his patients lived six weeks and one three months after operation, which shows that something can be accomplished.

DR. CHARLES G. MIXTER (Boston, Mass.).—Doctor Gage's paper has been of great interest to me as for many years much of my work was devoted to the surgery of infants and children. He is to be congratulated on developing a technic that bids fair to offer a chance of success in this disastrous anomaly that up to the present time has invariably proved fatal.

He has spoken of the frequency of its occurrence. Our experience at the Children's Hospital in Boston entirely corroborates his statement. In the past ten years 23 instances of tracheo-esophageal fistula have been observed. We have classified esophageal malformations into two main groups, *i.e.*, (1) those in which the esophagus ends blindly and, (2) those in which there is a tracheal fistula. The second group may be subdivided into three classes.

Sixty per cent belong to the class in which the distal segment has a fistulous opening into the trachea, the lower end of the proximal segment ending blindly.

Up to 1929, a palliative gastrostomy was done. This did not accomplish its purpose as all cases invariably died of pneumonia, caused directly by the fistula or indirectly by aspiration of the contents of the blind esophageal segment. The site of the fistula has always been found just above the bifurcation of the trachea. In 1929, I made my first operative attack on the tracheo-esophageal fistula by a posterior approach through the posterior mediastinum on the right side. A considerable extent of two ribs at the level of the bifurcation were excised; by pushing the pleura laterally the region of the fistula was readily exposed. The right azygos vein usually crosses over the fistulous communication and this is dislocated and the opening severed and sutured. The separated distal segment of the esophagus is brought out and implanted in the incision in the back or in a stab wound. A catheter is placed through the esophagus to the stomach for feeding purposes. The first infant lived 57 hours following operation before succumbing to the pneumonia which was present before operation. After several futile attempts, it was found that distal esophagostomy was insufficient, as overflow of secretion from the blind proximal end was followed by a fatal pneumonia. Therefore, proximal esophagostomy through the neck, either at the primary operation or within a few days, was added. Nine operative attempts have been made in the last six years, with and without proximal esophagostomy. All have ended fatally, but in two instances the infants have lived for 15 and 30 days, respectively. It is, of course, a palliative procedure, but it is hoped that, if the infant survives, an esophageal reconstruction can be done later.

DR. VILRAY P. BLAIR (St. Louis, Mo.).—I do not wish to encourage surgical exercises, but Doctor Mixer said something that I think has some value. If you meditate a radical operative attempt, do it at the earliest possible moment and you will have a better chance than on the older child, if you have any chance at all.

DR. MIMS GAGE (closing).—The object of presenting the subject of congenital tracheo-esophageal fistula was to stimulate discussion which may result in a more direct surgical attack on the lesion and thus lower the mortality rate and secure better end results.

Doctor Mixer's experience with these cases is of interest from the standpoint of his operative "transmediastinal approach." However, I do not believe that these patients can withstand any extreme dissection or manipulation. The surgical attack of the fistulous opening at its source is the ideal procedure, as it does not leave behind an esophageal pouch that will become infected and from which regurgitation into the tracheal tree will cause an acute pneumonitis. I agree with Doctor Blair's admonition that an infant can withstand more surgical trauma immediately after birth than it can several days later.

I should like to stress again the importance of keeping the upper esophageal pouch clean, in order to prevent filling and overflow with subsequent aspiration pneumonia. The upper esophagus should be mobilized to the outside as soon as possible. The lower segment must be drained by postural treatment with the head down until intratracheal manipulation, aspiration, and obliteration of the pouch can be accomplished.

ULCER OF THE PYLORIC SPHINCTER

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ULCERS within the grasp of the pyloric sphincter are uncommon. Their symptoms are often accentuated probably on account of their location. While the analogy is not entirely accurate because of the difference in the type of muscle and of nerve supply, the condition calls to mind a fissure in ano in which the discomfort and pain are caused not so much by the nature of the lesion as by its situation within the grasp of a band of muscle whose chief function is to remain tonically contracted, opening and closing at intervals under physiologic stimuli.

It is difficult to make a definite diagnosis of ulcer of the pyloric sphincter, because accurate localization of the lesion by roentgenology is often impossible. The intense spasm frequently overshadows the ulcer, though by fluoroscopic study and with numerous plates a roentgenologist can usually predict that an ulcer will be found somewhere in the region of the pylorus. Ulcers that originate on either the gastric or the duodenal side of the sphincter may touch or involve the tissue lining the pyloric sphincter, but these are not truly of the pyloric ring. According to Eusterman, the incidence of ulcers confined to the pyloric sphincter is not more than three or four per cent of peptic ulcers of all kinds. True ulcers of the pyloric ring must of necessity be gastric ulcers, because the gastric mucosa normally prolapses through the pyloric sphincter, and if histologic section shows an ulcer at the pyloric sphincter of duodenal tissue it cannot be classed as an ulcer of the pyloric ring.

While there is no distinct clinical entity in this group of cases, there are certain features which may suggest the probability of this type of ulcer. Eusterman mentions them as follows: "The comparatively brief duration of symptoms at the time the patient sought relief; the stormy course in the majority of cases, attributed to painful spastic manifestations; the pyloric obstruction of variable degree, resulting from spasm, inflammatory reaction or cicatrization; the dilatation of the stomach, even in the absence of consistent pyloric obstruction; the high volume of gastric content; the preponderance of ulcers in men, and the difficulty of clinical and roentgenologic diagnosis so far as actual localization of the lesion to the ring is concerned."

In the Proceedings of the Staff Meetings of the Mayo Clinic (vol. 10, p. 435, July 10, 1935), W. L. Butsch states that this lesion is comparatively rare—that only 46 cases of ulcer of the pyloric ring could be found in the surgical records of the Mayo Clinic for the last 15 years. Ten of these ulcers were excised and were found to be benign, and the pathologic diagnosis of the remaining 36 cases was not known. Eleven per cent of the cases in this series reported by Butsch showed apparent achlorhydria; the average value

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for free hydrochloric acid was 36.5, which is 6.7 units below the normal level of free hydrochloric acid. In typical gastric ulcer free hydrochloric acid is only 5.4 units below the normal level. Usually there is some dilatation of the stomach with obstruction. The average age of the patients was 47 years, which is about the age of patients with gastric ulcer. Of the 46 cases, 41 were males and five were females.

The symptoms averaged about 6.1 years, though in seven cases "dyspepsia" had been present for 15 years, and if these were eliminated the average would be greatly reduced. Butsch states that the average duration of symptoms before the patient applied to the Mayo Clinic for examination is much shorter

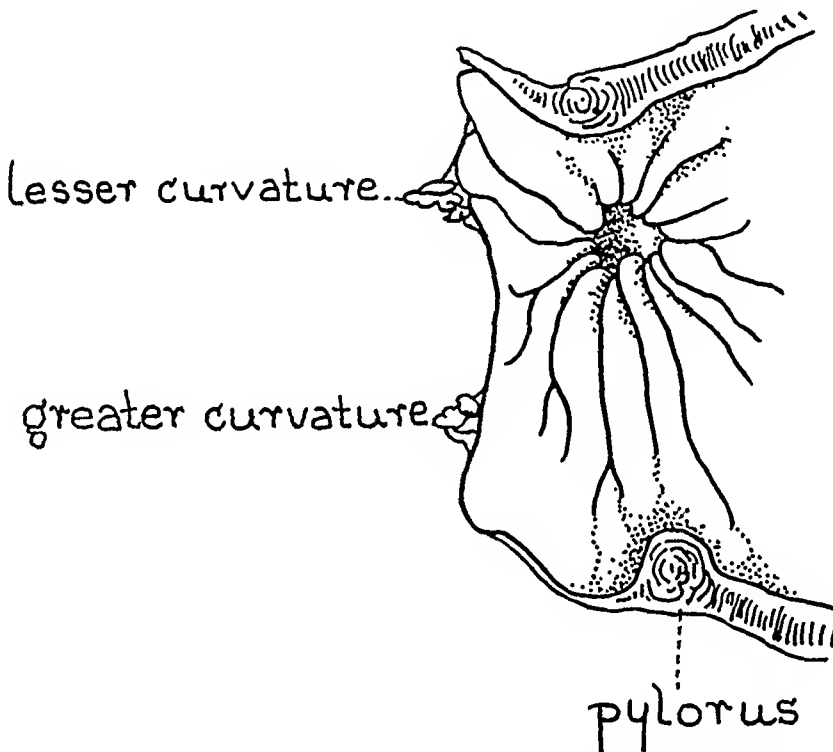


FIG. 1.—W. E. G., Surg. No. A-1565. White male, aged 36. First symptoms eight years ago, with violent attacks of pain in the stomach about 15 minutes after meals, followed by nausea and vomiting. He was relieved by diet in three weeks, and two months later had dyspepsia temporarily relieved by medication. Attacks were worse in the past three months. He lost 20 pounds in the past three years. The average free hydrochloric acid was 51.25. Operation, March 10, 1927. Appendectomy, cholecystectomy, and partial gastrectomy. The stomach specimen shows peptic ulcer in the pyloric sphincter, in the upper anterior wall.

in ulcer of the pyloric ring than in either duodenal or gastric ulcer, and he found that the significant symptomatology of this ulcer is that the duration of the symptoms is usually shorter and the course more stormy, with comparatively little relief by ordinary medical treatment.

Of the 46 cases reported from the Mayo Clinic for the last 15 years, resection of the pylorus and the adjacent portion of the stomach was done in only ten cases. In these there was a Billroth II type of partial gastrectomy. In the remaining 36 cases a posterior gastro-enterostomy was performed, and the diagnosis depended solely upon the observation of the surgeon. In many of these cases there were adhesions and perforation, which contra-indicated a partial gastrectomy. Consequently, it would seem impossible to establish

accurately the location of the ulcer in these 36 cases. Even when a partial gastrectomy has been done and the specimen opened and examined, the exact location of the lesion in its relation to the pyloric sphincter may sometimes be difficult.

During the past 11 years, from September 12, 1924, to October 23, 1935, I

have operated upon 12 cases of peptic ulcer either solely or partly within the pyloric ring. Of those that were entirely within the pyloric ring there were nine cases. Of those that apparently originated elsewhere and extended to the pyloric ring there was one. Of cases within the pyloric ring and with ulcers elsewhere there were two. In all of these 12 cases a partial gastrectomy, a modification of Billroth I method, which has been described elsewhere, was done.

During this time I have done 173 operations for peptic ulcer of all kinds, so that the percentage of operations for ulcer in the pyloric ring to total operations for peptic ulcer is 6.94 per cent. This rather high percentage of ulcers in the pyloric ring in comparison with operations for peptic ulcers elsewhere should not be assumed to be the proper ratio of the actual incidence of this ulcer, because peptic ulcers in other locations respond more readily to medical treatment and often do not need operation.

It may be that during this period of 11 years there have been in my practice more ulcers within the pyloric sphincter than I am reporting in this paper. In operations in which,

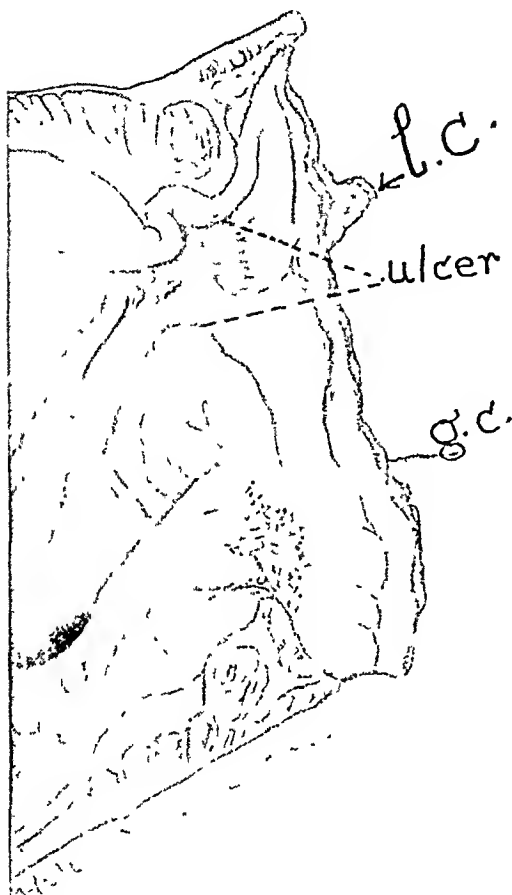


FIG 2—W. W. F., Surg. No. B-1455. White male, aged 46. Three months before admission the patient had severe pains in the epigastrium, relieved by food and alkalies. There were no previous symptoms, no nausea, vomiting, nor tarry stools. Average free hydrochloric acid was 75. Roentgenogram showed a filling defect on the gastric side of the pylorus. Operation, August 8, 1935. Partial gastrectomy and appendectomy. Specimen, opened behind, shows an ulcer within the grasp of the pyloric sphincter, and adjoining it is a superficial erosion, on the posterior side of the lesser curvature.

for instance, gastro-enterostomy was done, particularly if there was much inflammation about the region of the first part of the duodenum and the prepyloric portion of the stomach, there may have been a lesion within the grasp of the sphincter. However, it seems impossible to make an accurate diagnosis of ulcer in the pyloric sphincter, unless the pyloric end of the stomach has been excised and the position of the ulcer carefully noted in the specimen removed. Consequently, all the cases of ulcer within the pyloric

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ring that are here reported are based upon the observation of the position of the ulcer in the specimen removed by a partial gastrectomy.

In two cases in which a description of the operation and the observation



FIG. 3.—C. R. M., Surg. No. A-7311. White male, aged 42. A year before admission the patient had occasional cramps in the epigastrium after eating. This was accompanied by nausea and relieved by vomiting. The pain increased in frequency and severity until on admission the cramps and nausea followed everything ingested, but there was immediate relief by vomiting. He lost 21 pounds in the past three weeks. The average free hydrochloric acid was 51.25. Roentgenogram showed a penetrating ulcer of the pylorus. Operation, August 11, 1934. Appendectomy, resection of anterior gastric vagus nerves, and partial gastrectomy. Specimen shows a single rather deep ulcer in the grasp of the pyloric sphincter. Inset shows the depth of the ulcer. It was in the upper posterior portion, and the base of the ulcer involved pancreatic tissue.

of the lesion were dictated immediately after the partial gastrectomy, it was recorded that the ulcer was in the pyloric ring, and the specimen was preserved in formalin. Many months afterwards, when the specimen was again

examined, the ulcer appeared to be distinctly on the duodenal side. However, microscopic examination showed the surrounding tissue to be gastric mucosa (Broders). The ulcer which was not deep had been shoved through the sphincter by the hardening process of the formalin.

The symptoms are by no means similar in each case, and yet on the whole they seem to bear out the observations of Eusterman and Butsch, in the severity of the symptoms, and in the fact that relief by medical means is apparently more difficult than in ulcer either of the stomach higher up or of

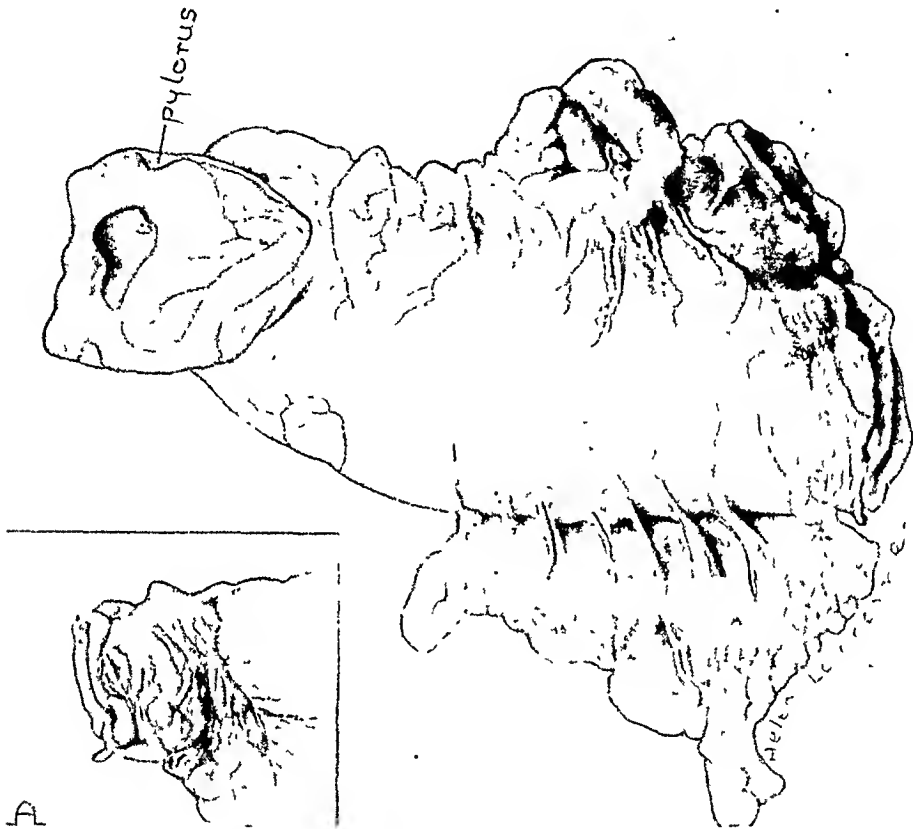


FIG. 4.—Mrs. M. B. H., Surg. No. A-7000. White female, aged 58. Had suffered from indigestion for the past 18 years. Seven years ago had an attack of pain in the gallbladder region, with nausea and vomiting. Two years ago an attack of weakness with nausea and vomiting. There was flatulence after meals. Twelve days before admission there was pain in the epigastrium, with fulness in the abdomen and nausea and vomiting. These symptoms continued at intervals up to admission. The abdomen was markedly tender in the upper right quadrant. It appeared to be an acute condition, possibly a slow penetration of an ulcer. The patient was of the ulcer type. There was no gastric analysis or roentgenologic examination. Operation, October 21, 1931. Partial gastrectomy. The specimen shows an ulcer within the grasp of the pyloric sphincter in the posterior portion which had penetrated into the pancreas. Inset shows a portion of the pancreas removed, which formed the base of the ulcer.

the duodenum. The symptoms may be periodic discomfort or hunger pain often only incompletely relieved by food, soda, or vomiting. Severe bleeding occurred in two of the cases. On account of the spasm, symptoms and sign of obstruction with late emptying of the stomach are common. The roentgenologic diagnosis, though not always positive, is helpful in that it shows unusual spasm, but without the filling defect or local deformity that is supposed to be characteristic of ulcer in the stomach or in the duodenum.

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The ulcers may be penetrating, but even if they are not the amount of spasm and obstruction that occurs is very marked and often out of proportion to the small lesion. This is doubtless caused by the location of the ulcer.

The treatment for this condition is partial gastrectomy, using preferably a modification of the Billroth I type of operation that we have adopted during the past 12 years. The advantages of this procedure for this lesion are rather obvious. Even though the gastric acidity is not high as a rule in these cases,

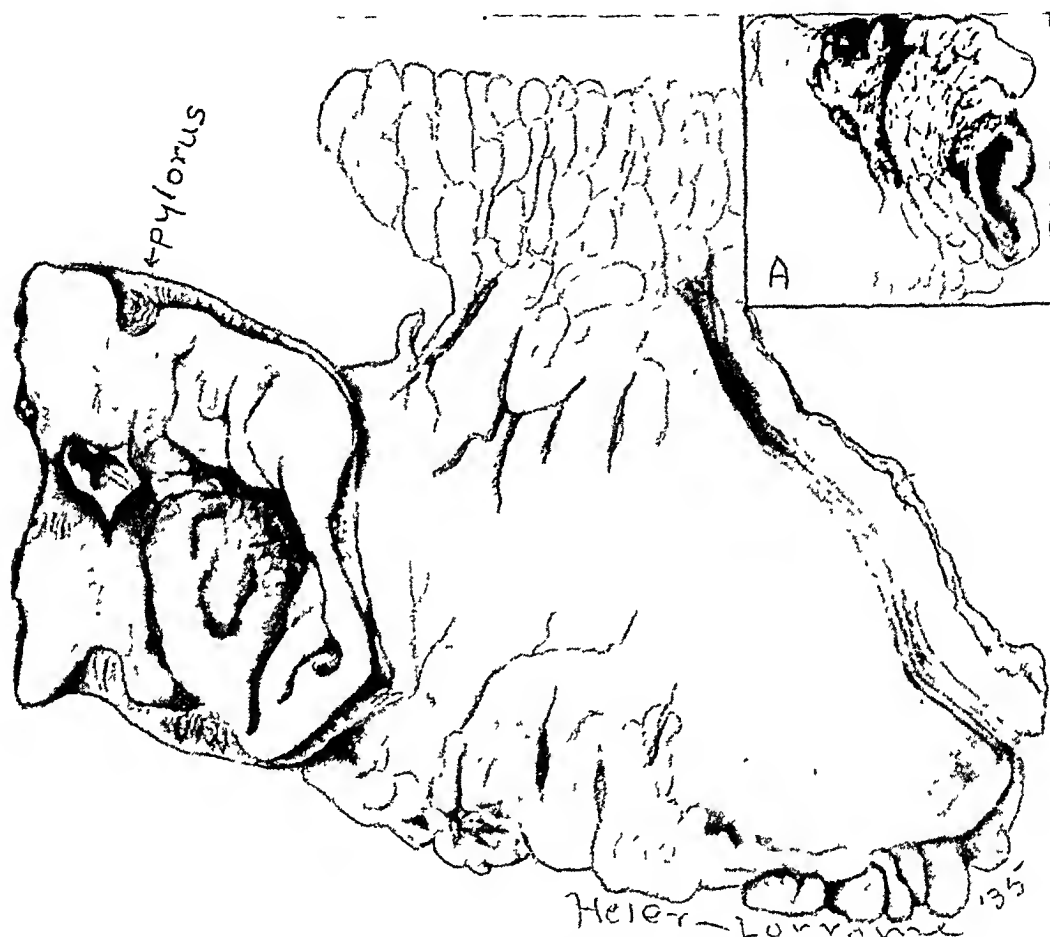


FIG. 5.—R. E. C., Surg. No. B-750. White male, aged 47. Twenty years ago the patient was jaundiced. Each year, usually in the fall, for the past 15 years, he had abdominal pain relieved by food and medication. These attacks increased in severity and in frequency, and in the past two years they had been accompanied by vomiting that was almost projectile. Twice he had formal medical treatment extending over some weeks. The last attack began six days before admission to the hospital, and was almost continuous to the time of admission. There were nausea and vomiting, and cramps so severe as to require hypodermics of morphine. He occasionally vomited blood, and lost some weight. The average free hydrochloric acid was 16.5. Roentgenologic examination showed a duodenal defect. Operation, January 10, 1935. Appendectomy, resection of the anterior gastric vagus nerves, and partial gastrectomy. Specimen shows a deep penetrating ulcer within the posterior portion of the grasp of the pyloric sphincter. Inset shows the portion of the pancreas which was removed, which formed the base of the ulcer.

which frequently suggests the probability of cancer, there is a tendency toward ulcer formation. In one of our cases there were ulcers elsewhere. It seems quite possible that some of these apparently solitary ulcers within the pyloric sphincter, are surviving lesions after ulcers in other portions of the stomach or duodenum have healed. They, too, doubtless would have healed but for the influence of the pyloric sphincter. At any rate, it would seem to be the part of wisdom to provide, as far as can be, against a recurrent ulcer, by having

the stomach discharge its contents into the duodenum instead of into the jejunum. As is well known, the sensitivity of the mucosa of the gastrointestinal tract to irritation from the gastric juice increases from the duodenum down to and including the large bowel. If, after the resection, the stomach is united to the duodenum and at the same time the normal relationship of the physiologically important lesser curvature with the upper border of the duodenum is maintained, not only will a cure probably be effected but a

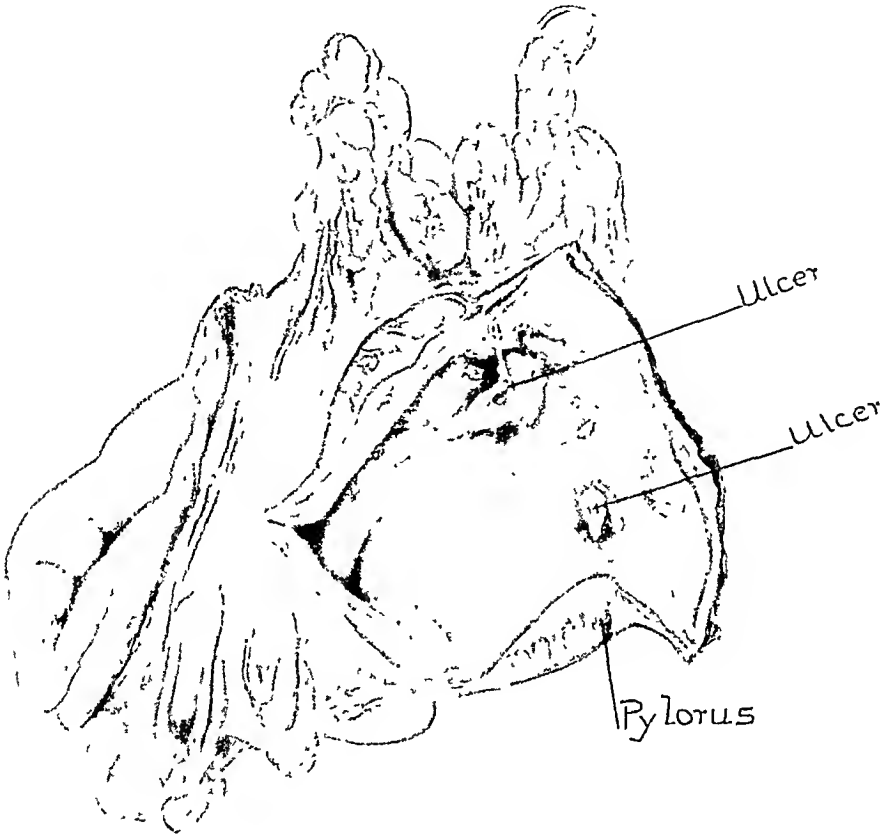


FIG. 6—C. C. B., Surg. No. A-771. White male, aged 47. The patient had bilious spells at rare intervals, and anorexia and indigestion for 10 or 12 years, but the attacks were never very severe. The day before admission, after a heavy meal, he was nauseated and vomited dark material which was probably blood. The following morning after breakfast he vomited large quantities of bright blood. He was admitted to the hospital later in the day. On account of the bleeding there was no gastric analysis nor roentgenologic study. May 17, 1926, five days after admission to the hospital, a partial gastrectomy and appendectomy were performed. Specimen shows two ulcers within the grasp of the pyloric sphincter, one on the posterior wall at the lesser curvature, and the other on the lower border.

restoration of the physiologic function of the stomach and duodenum will be more nearly accomplished than by other methods.

That partial gastrectomy is the proper treatment for this type of ulcer seems to be supported by a consideration of the clinical and pathologic features of this lesion. As has been mentioned, a true ulcer of the pyloric sphincter always has a background of pyloric (gastric) mucosa, because this mucosa normally lines the pyloric sphincter. An ulcer of the pyloric ring, then, is a gastric ulcer whose symptoms are usually accentuated.

Most of the ulcers in this series of cases have been on the posterior wall

of the sphincter, either in the center penetrating to the pancreas, or near the upper or lower borders of the stomach. In such cases though a pyloroplasty will expose the lesion which may, of course, be excised and the mucosa sutured, local excision and suturing of a gastric ulcer elsewhere in the stomach is often unsatisfactory. Dragstedt and Vaughn (Gastric Ulcer Studies, Arch. Surg., vol. 8, p. 791, 1924) have shown that one of the best methods of creating an experimental gastric ulcer in a dog is to place sutures in the pyloric portion of the gastric mucosa. A good treatment for an ulcer in the right half of the stomach is partial gastrectomy. This pyloric ring type of ulcer not only has the vices of a gastric ulcer elsewhere, but is peculiarly liable to hemorrhage. We had two cases of very severe hemorrhage in this series of 12 cases. It also often perforates and, like other gastric ulcers, may become malignant. Pyloroplasty is not by any means free from the occurrence of a late stricture. If a gastro-enterostomy is established, a jejunal ulcer may result, and this is worse than the original ulcer. If a pyloroplasty is performed, and there is a recurrent ulcer, a partial gastrectomy will be much more difficult than it would have been if a partial gastrectomy had been done in the first instance. As to the danger, while this series of cases is small (12) there were no fatalities.

In the 12 cases, which are being reported, a partial gastrectomy by a modification of the Billroth I type was done. In nine of the cases the lesion was solely within the pyloric sphincter; in one the ulcer invaded the sphincter from the duodenal side; in two cases there was also an ulcer elsewhere.

The average age of these 12 patients was 46.6 years. Two of them were women, and ten were men. The average duration of symptoms was 10 $\frac{3}{4}$ years, the duration of the symptoms varying from three months to 20 years. Several of the patients gave a long standing history of indigestion, but the severe symptoms were of only recent date. There was severe pain in nine cases, mild pain in one case, and two patients complained of no actual pain. In the latter two cases there was vomiting of much blood, and there was some bleeding in one other case. In nine cases there was a history of vomiting. A gastric analysis was done in ten of these cases. The average value for free hydrochloric acid was 32.9 units. The highest average value of free hydrochloric acid in any one case was 75. In two cases there was no free hydrochloric acid.

In ten cases a roentgenologic examination was made, and in three obstruction was present after 24 hours. One patient was operated upon immediately as an emergency on account of severe symptoms, and in one other patient, operated upon a few days after admission, there had been a severe hemorrhage from the stomach and no gastric analysis or roentgenologic examination was made. Six of these patients were obviously of the so called ulcer type; in four the type was unknown; in two unrecorded.

In one case the ulcer was partly within the pyloric sphincter, but chiefly on the duodenal side. The patient was a man, 47 years of age. The symptoms had extended over ten years, but were severe only recently. There had been no vomiting. Gastric analysis showed an achlorhydria. Roentgenologic ex-

amination showed retention after 24 hours. The patient was of the ulcer type. Two cases had multiple ulcers. The average age of these patients was 51.5 years. One was male, and the other female. The average duration of symptoms was 14.5 years. One had severe pain; the other had no pain, but acute hemorrhage. There was vomiting in one case. The average value of free hydrochloric acid was 27.1 units.

In the nine patients with ulcer entirely within the pyloric sphincter, there were eight men and one woman. The average age was 45.5 years. The average duration of symptoms was 9.9 years. There was severe pain in seven cases, mild pain in one, and no pain in one. There was vomiting in eight cases. Two patients had a history of bleeding, severe in one and only occasional slight bleeding in the other. Five of the patients were of the so called ulcer type. The average value of free hydrochloric acid was 39.25 units. There was no free hydrochloric acid in one case; the highest was in one patient in whom the value was 75 units. In one case the roentgenologic examination showed obstruction after 24 hours.

Dr. Douglas G. Chapman rendered valuable aid in the analysis of the symptoms of these cases.

MECKEL'S DIVERTICULUM WITH PEPTIC ULCER

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GOLDSBORO, N. C.

MECKEL'S diverticulum is due to the persistence of a portion of the vitelline duct or yolk stalk. Being a rudimentary blind pouch on the intestinal tract, it is subject to the same disease processes which have brought fame and dishonor to the appendix—inflammation, gangrene and perforation.

Johann Meckel⁴⁶ (1781–1833) discovered this diverticulum and described its anatomic origin. In his description of the diverticulum (1812) Meckel states that "The structure of the inner layer is exactly the same as in the portion of the intestine from which the diverticulum springs." He evidently did not recognize that, at times, the diverticulum is lined entirely or in part by gastric mucosa and that it may be the seat of peptic ulcer formation with subsequent hemorrhage and perforation. Denecke,¹⁶ in 1902, reported the first ulcer in Meckel's diverticulum but it remained for Deetz,¹⁴ in 1907, to point out the occurrence of gastric mucosa in these cases and to stress the peptogenic character of these ulcerations.

Incidence.—The incidence of Meckel's diverticulum is difficult to determine. Because few surgeons make a routine search for its presence, operating room statistics are not accurate. At the Johns Hopkins Hospital, 15 cases were found in 2,600 necropsies, or .57 per cent, while Mitchell, of Chicago, in 1,635 autopsies reported 39 cases, or 2.38 per cent. From these combined figures the incidences can be placed at 1.2 per cent. It occurs twice as often in males as in females.

Peptic ulcer seems to be the most common complication of Meckel's diverticulum. Schaetz⁶³ in a careful study of 30 diverticula found that 50 per cent contained abnormal elements. Pancreatic tissue or mucosa resembling that of the duodenum or jejunum may be found within its lumen. He estimates the incidence of gastric mucosa at 16 per cent. Certainly all cases containing gastric mucosa are cases of potential ulcer with hemorrhage and perforation.

Huebschmann³⁴ compares the ulcers in Meckel's diverticulum to the gastro-jejunal ulcers following gastro-enterostomy. In both instances the ulcerations occur at the junction of the gastric and intestinal mucosa. Schaaff⁶² analyzed the fluid content of the diverticulum removed by him and found it to contain 40 free hydrochloric acid and 70 total acidity.

Lindau and Wulff⁴⁴ call attention to the fact that the secretion of hydrochloric acid from gastric mucosa contained in a Meckel's diverticulum "begins or increases synchronously with the activity of the stomach—this implies that the production of gastric juice in Meckel's diverticulum occurs at a time during which the small bowel is empty and when no neutralization takes place by food and intestinal juice. In such manner especially favorable

conditions are created for the generation of peptic lesions, a circumstance that we find borne out by the occurrence of these ulcers in Meckel's diverticulum even at an early age."

Besides this article by Lindau and Wulff other excellent articles dealing with peptic ulcer in Meckel's diverticulum have recently appeared by Mason and Graham,⁴⁵ and Johnston and Renner.⁴⁰ A review of the literature reveals 98 cases, including one previously published by the author. To this number I would like to add two more, making a total of 100.

CASE REPORTS

Case 1.—R. K., a white boy, aged 9, was first seen in 1931. At that time he had several severe exsanguinating intestinal hemorrhages, passing large amounts of light and dark blood. There had been no pain associated with this condition and his past history was negative for any abdominal discomfort or digestive disturbance. This boy was seen a short time after another patient had been operated upon for a perforated peptic ulcer of Meckel's diverticulum and with this case freshly in mind, a diagnosis was made of bleeding ulcer of Meckel's diverticulum and operation was advised. The parents refused operation, however, and took the child home.

He was seen again, one year later (1932). In the interim he had had no further intestinal hemorrhage and had had no abdominal discomfort. On this second visit he did complain of diffuse abdominal discomfort of 48 hours' duration. This discomfort had become localized in the right lower quadrant where he complained of much tenderness. There had been no nausea and vomiting. Physical examination revealed a well nourished and developed boy of 10 years. All findings were negative except marked tenderness and rigidity in the right lower quadrant. His temperature was 98.6° F.; pulse, 88; white blood count, 13,000 with 91 per cent neutrophils; the urinalysis was negative. From these findings a diagnosis was made of acute appendicitis associated with a peptic ulcer in a Meckel's diverticulum.

The patient was operated upon the same day, using a right midrectus incision. The appendix was found situated retroceally and was very acutely inflamed. After the appendix was removed, exploration of the lower ileum showed, about 18 inches from the ileocecal valve, a Meckel's diverticulum situated on the antimesenteric border. The diverticulum was 6 cm. long and 2 cm. in diameter at its base, tapering to the tip, and was conical in shape. There was a fibrous cord, the size of a match, running from the tip of the diverticulum to the umbilicus (Fig. 1). The diverticulum was resected, removing a cuff of ileum. The adjacent mucous membrane of the ileum appeared normal. The opening in the ileum was closed transversally with two rows of Lembert sutures, and the abdominal incision was closed without drainage. The patient made an uneventful convalescence and was discharged from the hospital 12 days later.

Microscopic examination by Dr. J. B. Bullitt.—"The mucosa is thick and is thrown into a number of rugae. The surface epithelium is tall columnar, with clear cytoplasm and basal nuclei. Beneath this, there are fairly long tubular glands, lined with columnar epithelium which takes a fairly deep stain; between these columnar cells are a moderate number of globular cells with eosinophilic granules. This picture resembles the mucosa of the stomach. At one end of the specimen there is a small piece of the gut; and at the juncture of the two types of mucosa, there is a shallow ulcer, whose base is covered with a thin layer of necrotic debris (Fig. 1A). A very moderate amount of leukocytic exudate is about the ulcerated region, and a scanty leukocytic infiltration is seen everywhere throughout the specimen. The muscularis is scantily developed, consisting of merely occasional bundles of fibers imbedded in a thick layer of connective tissue."

Case 2.—J. P., a white male infant 1½ years old. This patient was brought in with the complaint of excruciating abdominal pain, and the passage of bloody stools. The

parents stated that the child had always seemed healthy. Four days before admission they noticed the passage of a large, dark, offensive stool, resembling old blood. The child had four such stools the same day. The following morning, or three days before admission, while eating breakfast, the child complained of intense pain in the abdomen, and that same morning there was another dark, offensive, bloody stool. The following

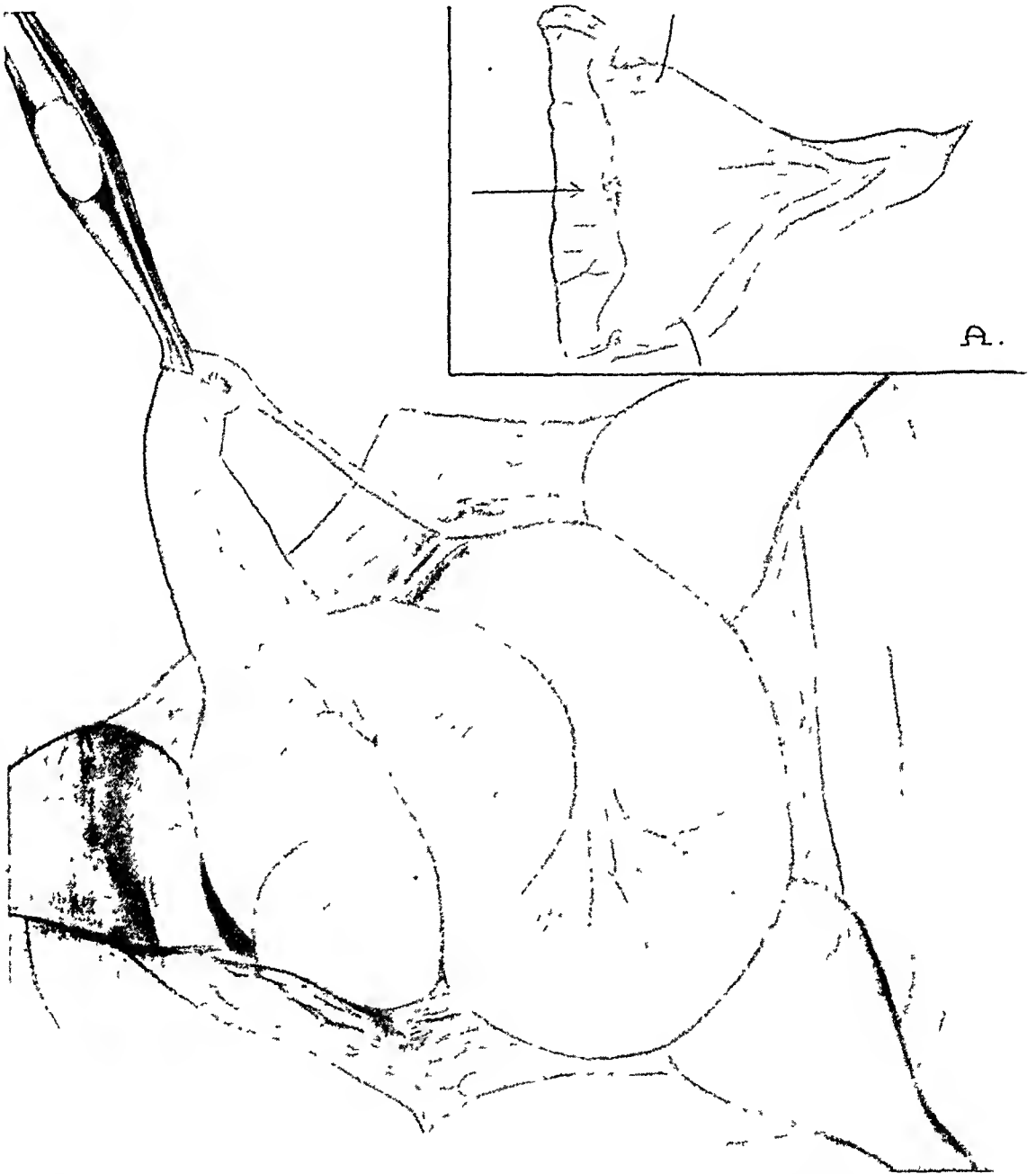


FIG. 1.—(Case 1.)—The Meckel's diverticulum as seen at operation presented no evidence of inflammation. Inset shows peptic ulcer at junction of gastric and intestinal mucosa. Gastric mucosa verified microscopically.

day the abdomen was somewhat swollen and the child began to vomit. The vomiting continued and the abdominal swelling gradually became more pronounced. A dose of castor oil was given the day the first bloody stool was noted, and again following the excruciating abdominal pain while eating breakfast on the next morning.

On examination the child was a well developed infant of 1½ years. He was in definite shock. The rectal temperature was 101.6° F., and the pulse was so thready and weak that it could not be counted. The abdomen was markedly and diffusely distended; it was tympanitic throughout. There were no palpable masses; there were no definite

TABLE I
ULCER CASES WITH MICROSCOPICALLY VERIFIED GASTRIC MUCOSA

Author	Year	Age	Sex	Symptoms		Prooperative Diagnosis	Ulcer Perfo- rated	Recov- ered	Died	Remarks
				Pain	Intesti- nal Hemor- rhage					
1. Hilgenreiner ³³	1903	18	M.	+	+	Appendicitis	-	+		
2. Deetz ¹⁴	1907	9	M.	+	-	Appendicitis	+	+		
3. Huebschmann ²¹	1913	4½	M.	+	+	Peritonitis	+		+	Diverticulum found at au- topsy
4. Gramen ²⁷	1915	10	M.	+		Appendicitis	+	+		
5. Callender ⁷	1915	19 mos.			+		-		+	Found at autopsy. Death from hemorrhage
6. Meulengrecht ¹⁹	1918	12	M.	+	+		-		+	Death from other cause. Found at death
7. Mueller ⁵¹	1919	11	M.	+	+	Peritonitis	+	+		
8. Megevaud and Dunant ¹⁷	1922	28	M.	+	+	Duodenal or in- testinal ulcer	-	+		
9. Brasser ³	1924	15	M.	+	+	Tumor or polyp	+		+	Cause of bleeding not found at operation. Di- verticulum at autopsy
10. Humbert ⁴⁷	1924	11 mos.	M.	+	+	Peritonitis	+		+	Diverticulum found at au- topsy
11. Guibal ¹³⁰	1924	14	M.	+	+	Intestinal tuberculosis	-	+		
12. Pascale ⁵⁷	1925	41	F.	+	+	Intestinal ulcer	-	+		
13. Ulrich ⁷⁵	1925	8 mos.	M.	+	+	Peritonitis	+	+	+	
14. Abt and Strauss (Case 1) ¹	1926	2	F.	+	+		-	+		
15. Etchegorry ²⁰	1926	16	M.	+		Appendicitis	+	+		

TABLE I (Continued)

Author	Year	Age	Sex	Symptoms		Preoperative Diagnosis	Ulcer Perfo- rated	Recov- ered	Died	Remarks
				Pain	Intesti- nal Hemor- rhage					
34. Achsner and Kareltz ² .	1930	2	M.	+	+	Intussusception	-	+		
35. Fevre, Patel and Lepart ²²	1930	7	M.	+		Appendicitis	+	+		
36. Fevre, Patel and Lepart ²²	1930	5 mos.	M.	+	+	Intussusception	+	+		
37. Cobb ¹⁰	1931	18	M.	+	+	Appendicitis	+	+		
38. Debre ¹³	1931	17 mos.	M.	+	+		+		+	
39. Buehner ⁵	1931	8	F.	+			-	+		
40. Tavernier and Guilleminet ⁷²	1931	10	F.		+	Possible ulcer of Meckel's diverticulum	-	+		
41. Lindau and Wulff ⁴¹	1931	15	M.			Appendicitis				Operated upon for appendicitis. Diverticulum found at autopsy
42. Greenwald and Steiner ²⁹	1931	15 wks.	M.	+		Perforated ulcer of Meckel's diverticulum				
43. Greenwald and Steiner ²⁹	1931	10	M.	+	+		+	+		
44. Hudson and Koplik (Case 12) ³⁵	1932	5½	M.	+	+	Peritonitis	+		+	
45. Hudson and Koplik (Case 31) ³⁵	1932	5½	M.	+	+		-	+		
46. Vaughn and Singer ⁷⁷ ..	1932	7	M.	+		Appendicitis	+	+		
47. Mason and Graham ⁴⁶ ..	1932	9 mos.	M.	-	+		-	+		

48. Goetsch ³⁶	1932	19	M.		Intestinal obstruction	Healed	+	Ulcer had perforated and had drained 6 yrs. previously
49. Burger ⁶	1932	7	M.	+	Ileus	+	+	
50. Royster ⁶¹	1932	7	M.	+	Exploratory Appendicitis	+	+	+
51. Marty and Roudil ⁶⁰ ...	1932	7	M.	+		+		
52. Wulff ⁸¹	1932	16	F.			-	+	
53. Schaaff ⁶²	1932	7	M.	+	Perforated ulcer of Meckel's diverticulum	+	+	Diverticulum 60 cm. long, contained a fluid with 40 free HCl and 70 total acidity
54. Hudson ³⁶	1933	11	M.	+		-		+
55. Hudson ³⁶	1933	6 mos.	M.	+	Peritonitis	+		+
56. Dragstedt ¹³	1933	17 mos.	M.	+	Intestinal ulcer	-	+	
57. Johnston and Renner ¹⁰ .	1933	18 mos.	M.	+	Appendicitis	+	+	
58. Johnston and Renner ¹⁰ .	1933	15 mos.	F.	+	Ulcer of Meckel's diverticulum	-	+	
59. Clark ⁹	1933	8	M.	+		-	+	Multiple erosions
60. Lamy and Mondor ⁵³ ...	1933	4½	M.	+	Appendicitis	+	Not mentioned	
61. Del Carril ¹⁵	1934	2	M.	+		-	+	
62. Weeder ⁷⁹	1934	9 mos.	F.	+	Perforated ulcer of Meckel's diverticulum	+	+	
63. Deton and Huard (Case 1) ¹⁷	1935	18	M.	+	Ulcer of Meckel's diverticulum	-	+	
64. Deton and Huard (Case 2) ¹⁷	1935	11	M.	+	Ulcer of Meckel's diverticulum	-	+	
65. Croes and Van Hasselt ¹¹	1935	3½	M.	+		-	+	
66. Cobb (See text).....	1935	9	M.	+	Ulcer of Meckel's diverticulum	-	+	

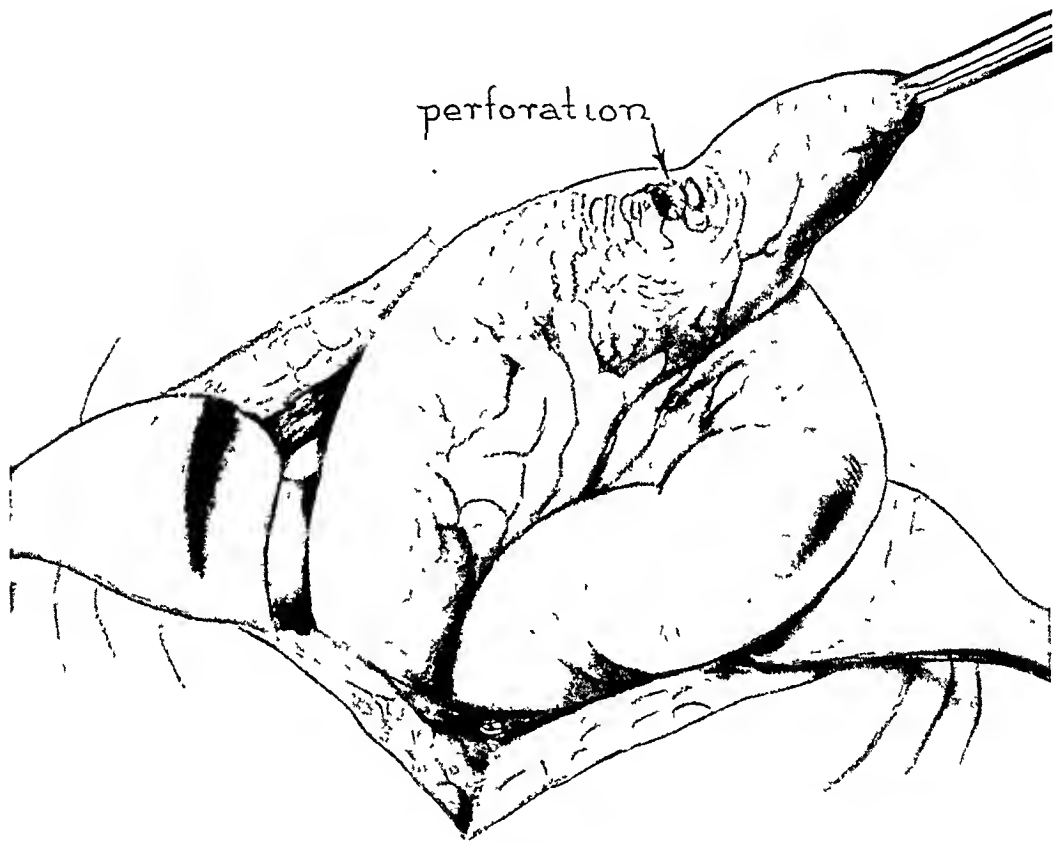
TABLE II
ULCER CASES. MUCOSA NOT INVESTIGATED

Author	Year	Age	Sex	Symptoms		Preoperative Diagnosis	Ulcer Perfo- rated	Recov- ered	Died	Remarks
				Pain	Intesti- nal Hemor- rhage					
1. Denecke ¹⁶	1902	7	M.	+		Appendicitis	+		+	
2. Brentano ⁴	1904	24	M.	+		Appendicitis	+	+		
3. Lawen ⁴³	1909	23	M.	+		Peritonitis	+	+		
4. Stern ⁶⁹	1917	5½	F.	+		Peritonitis	+	+		Large bowel mucosa
5. Stern ⁶⁹	1917	3	M.	+	+	Peritonitis	+	+		
6. Griffith ²³	1914	19 mos.	M.	+	+		+	+	+	Found at autopsy
7. Schreuder ⁶⁵	1923	8	M.	+	+	Duodenal ulcer (roentgen ray)	+	+		
8. Jackson, R. H. ³⁹	1924	10	M.	+	+	Surgical abdomen	-	+		
9. Stulz and Woring (Case 1) ⁷¹	1925	4 mos.	M.	+	+	Ileus, peri- tonitis	+		+	
10. Stulz and Woring (Case 2) ⁷¹	1925	11 mos.	M.	+	+		+		+	Found at autopsy
11. Abt and Strauss (Case 2) ¹	1926	1 mo.	M.	+	+		-	+		
12. Fuss ²⁵	1926	37	F.	+	+	Bleeding gastric ulcer	-	+		
13. Mol ⁶¹	1926	5 mos.			+	Intestinal polyp	-		+	Found at autopsy
14. Kleinschmidt ⁴¹	1927	45	M.	+	+	Tumor	+	+		
15. Shannon ⁶⁷	1928	18 mos.	F.		+	Ulcer of Meckel's diverticulum	+	+		
16. Winkelbauer ⁸⁰	1929	19 mos.	M.	+	+	Intussusception	-	+		No gastric mucosa on mi- croscopic examination

MECKEL'S DIVERTICULUM

17. Schwarz and Daly ⁶⁶	1929	8	M.	+	+	Bleeding ulcer of Meckel's diverticulum	-	+
18. Smith and Hill ⁶⁸	1929	14 mos.	M.	+	+	Intestinal obstruction	+	+
19. Christic (Case 3) ⁸	1931	3 wks.	M.				-	Found at autopsy
20. Christic (Case 10) ⁸	1931	2 wks.	M.	+	+		+	Found at autopsy
21. David ¹²	1932	30	M.	+	+		+	Ulceration may have been carcinomatous
22. Finney ²³	1932	29	M.	-	+	Ulcer of Meckel's diverticulum	-	No gastric mucosa found
23. McKeen ³⁶	1932	53	M.	+	+	Duodenal ulcer (roentgen ray)	-	No gastric mucosa on microscopic examination
24. Walters and Wilkins ⁷⁸	1932	20	M.	+	+	Intussusception	+	
25. Pougct and Tavernier ⁷²	1933	5	F.	+	+	Ulcer of Meckel's diverticulum	+	
26. Fellows ²¹	1933	19	M.	+	-	Appendicitis	+	Not stated
27. Miller and Wallace ⁵⁰	1933	17	M.	+	+	Acute obstruction	+	+
28. Valer, F. ⁷⁶	1934	8	M.	+	-	Peritonitis	+	No gastric mucosa on microscopic examination
29. Montgomery (Case 1) ³³	1935	13 mos.	M.	+	+	Ulcer of Meckel's diverticulum	-	
30. Montgomery (Case 2) ³³	1935	10 mos.	M.	-	+	Intussusception	-	
31. Montgomery (Case 3) ³³	1935	16 mos.	M.	+	+	Ulcer of Meckel's diverticulum	+	
32. Montgomery (Case 4) ³³	1935	11 mos.	M.	+	+	Ulcer of Meckel's diverticulum	+	
33. Pasman ³⁸	1935			+	+	Intussusception	+	Not stated
34. Cobb (See text)	1935	18 mos.	M.	+	+	Peritonitis	+	+
								No gastric mucosa on microscopic examination

areas of rigidity, but there was a sense of increased resistance in the right lower quadrant. The child was put to bed, treated for shock, and dextrose in Ringer's solution was administered. Eight hours later, the child's condition being slightly improved, an exploratory operation was decided upon. A positive preoperative diagnosis had not been made, but it was felt that the child had had some rupture of a hollow viscus. The operation was performed through a right rectus incision. On entering the peritoneal cavity there was much free fluid and some intestinal contents. Examination of the appendix showed it to be mildly inflamed at its tip; it was not ruptured and did not appear responsible for the symptoms. Further exploration showed numerous adhesions of the ileum to the anterior abdominal wall just below the umbilicus. On separating these adhesions a



Helen Borraine

FIG. 2.—(Case 2.)—Punched out perforation at margin of diverticulum. Gastric mucosa not found microscopically.

Meckel's diverticulum was disclosed. It could not be determined just how far from the ileocecal valve the diverticulum was situated. It arose from the antimesenteric border of the ileum, it was conical in shape, being 2.5 cm. in diameter at its base and 1.5 cm. at its tip, and about 4 cm. in length. At the junction of the diverticulum and ileum there was a punched-out perforated ulcer (Fig. 2). From this perforation was exuding a large amount of intestinal contents. The diverticulum was resected, removing a portion of the ileum. The opening in the ileum was closed transversely with two rows of Lembert sutures. No further exploration was done. The peritoneal cavity was washed out with ether, and two Penrose drains were placed in the pelvis. During the operation the patient received continuous intravenous dextrose in Ringer's solution, 500 cc. being given. Following the operation the child failed to react and died three hours later.

Pathologic examination by Dr. C. C. Carpenter.—“Gross description.—Specimen consists of a flattened piece of tissue that is 3.2 by 2.5 by .6 cm. To one side of the center is an oval perforation 0.3 cm. in diameter. The perforation is surrounded by a fibrino-purulent exudate. The lining consists of unbroken mucosa except for the point of perforation. The walls of the perforation are smooth and clean cut. Microscopic description.—Section shows the wall of the intestine, near the center of which there is a rounded perforation. The wall of the perforated area shows considerable necrosis and many neutrophils and lymphocytes. The mucosa for a considerable distance outside of the necrosed area shows necrosis with the submucosa and muscular layers preserved. An acute inflammatory reaction is seen throughout the section.”

One hundred cases have been reviewed and are tabulated in two groups. Table I contains 66 cases of ulcer in which gastric mucosa was demonstrated microscopically. Table II contains 34 cases of ulcer in which no microscopic examination was made, or in which no gastric mucosa was found. In the few cases in which no gastric mucosa was found, it is entirely possible that the microscopic search was not sufficiently thorough or the island of gastric mucosa that had been present was destroyed by the process of ulceration and perforation. In any event the symptomatology and the gross findings clearly belong to the peptic ulcer group. The two groups, therefore are considered together. It is upon a study of these 100 cases of peptic ulcer in Meckel's diverticulum that this paper is based.

Age.—This disease is essentially one of infancy and childhood. Although the ages in this series of cases ranged from two weeks to 53 years, the great majority occurred in early childhood. Seventy-four per cent were found in the first 15 years of life (Table III).

TABLE III

AGE DISTRIBUTION

From birth to fifth year.....	40	} 74%
Five to ten years.....	23	
Ten to fifteen years.....	11	
Over fifteen years.....	23	
Age not stated.....	3	
Total.....	100	

Youngest, 2 wks.

Oldest, 53 yrs.

Sex.—It has been noted that Meckel's diverticulum occurs twice as frequently in males. There is, however, a far greater preponderance of ulcer formation in males. Eighty-one of these ulcer cases occurred in males and 14 cases in females. Thus the sex distribution approximates that of duodenal ulcer and congenital hypertrophic pyloric stenosis. In five cases the sex was not stated (Table IV).

Pain.—There is usually some associated abdominal pain. This symptom was complained of in 80 per cent of these cases. The pain does not always have the typical text-book location in the right lower quadrant with radiation

TABLE IV
SEX DISTRIBUTION

Males.....	81
Females.....	14
Sex not stated.....	5
Total.....	100

to the umbilicus. It is not unusual for the discomfort to closely simulate that of duodenal ulcer, being situated in the epigastrium, and may be periodic or postprandial in nature, as in the cases of Megevaud,⁴⁷ Huebschmann³⁴ and the one previously reported by the author.¹⁰ At times, the pains are colicky in nature. These periodic, postprandial or colicky pains usually occur in the adult cases. In many instances, however, and especially is this true in children, there is no history of pain until the occurrence of perforation. Pain, of course, is much more frequent in the perforated cases, having occurred in 51 of the 55 cases, but it was also complained of in 29 of the 43 non-perforated cases.

Hemorrhage.—Intestinal hemorrhage is the most frequent complication. The bleeding may be profuse and in the non-perforated cases reported by Callender⁷ and Taylor,⁷³ it was the direct cause of death. The blood may be bright red but usually it will have undergone partial decomposition within the intestine and appear as a black, tarry stool, as though the hemorrhage had taken place high up in the intestinal tract. Mason and Graham⁴⁵ have previously emphasized the importance of intestinal hemorrhage as a diagnostic sign and have called attention to the fact that the bleeding may extend, intermittently, over a period of months or years, often being traceable to infancy or very early childhood. Intestinal bleeding was present in 72 of these 100 cases. It occurred with equal frequency in the perforated and non-perforated groups (Table V).

TABLE V

INCIDENCE OF PAIN AND INTESTINAL HEMORRHAGE AND THE MORTALITY IN PERFORATED AND NON-PERFORATED ULCERS IN MECKEL'S DIVERTICULA

	No.	Pain	Intestinal Hemorrhage	Died	Mortality Percentage
Perforated ulcers.....	55	51	36	20	36
Non-perforated ulcers.....	43	29	36	5	12
Perforation not stated.....	2	—	—	—	—
Total.....	100	80	72	25	27

Perforation.—Next to hemorrhage, the most frequent, and the most serious complication in peptic ulcers of Meckel's diverticulum is perforation. This occurred in 55 of the 100 collected cases.

It is not definitely known why ulcers of Meckel's diverticulum have such

a strong tendency to perforate. It is true, however, that the walls of these diverticula are often poorly formed, containing, at times, but little musculature, and thus form a much thinner base for the ulcer than is the case in gastric or duodenal ulcer.

That perforation is an extremely dangerous complication is shown by the fact that 20 of these 55 cases died, a mortality of 36 per cent. No stronger argument could exist for an earnest attempt at early diagnosis and early operation, before the perforation has occurred. The contents of the lower portion of the ileum being more infective than that of the stomach and duodenum, it is natural to suppose that a perforation in this location would be very dangerous. In the 43 non-perforated cases there were five deaths, a mortality of 12 per cent. Four of these cases, however, were not recognized during life but were found at autopsy. About the fifth case no particulars are given. In the cases that were operated upon before perforation had taken place there were no deaths.

Diagnosis.—The correct preoperative diagnosis of peptic ulcer of Meckel's diverticulum must necessarily be made by the process of exclusion. It is essential, of course, that the possibility be kept in mind. During recent years the literature has contained an increasing number of articles dealing with this condition and as a result of this a correct diagnosis has been made with increasing frequency. The more common causes of abdominal pain and melena, such as gastric and duodenal ulcer, polyps, malignancy, intussusception, a low grade ulcerative colitis and hemorrhoids must first be excluded.

TABLE VI

PREOPERATIVE DIAGNOSES

Ulcer of Meckel's diverticulum.....	17
Appendicitis.....	18
Peritonitis.....	18
Intussusception or obstruction.....	10
Duodenal or gastric ulcer.....	5
Intestinal tumor or polyp.....	4
Acute abdomen.....	3
Intestinal ulcer or tuberculosis.....	3
Ileus.....	1
Not stated.....	21
Total.....	100

The 17 cases correctly diagnosed were reported since 1927, six of them during 1935.

The diagnosis was first correctly made by Dr. E. A. Ketterer, of Montport, Wis., in 1927. He had seen a similar case previously. Since then, a total of 17 correct preoperative diagnoses have been made, six of which were during 1935.

In the non-perforated cases there were nine correct diagnoses. Their ages ranged from 13 months to 29 years. All of these cases passed large amounts

of blood, many of them intermittently over a period of months or years. Most of them complained of some abdominal pain. This was either colicky in nature and closely related to the time of bleeding or it was periodic and postprandial in character, resembling duodenal or gastric ulcer. Such a diagnosis is justifiable only after excluding the more common causes of melena and abdominal pain. When, however, no apparent cause can be found for such symptoms, an exploration is justified in order that an ulcerated diverticulum might be found and removed before perforation has taken place.

In the perforated group there were seven correct diagnoses. Their ages ranged from seven months to seven years. All of these cases, too, had passed large amounts of blood by rectum. Six of them had much abdominal pain. (In one case this was not stated.) It is true that the great majority of the

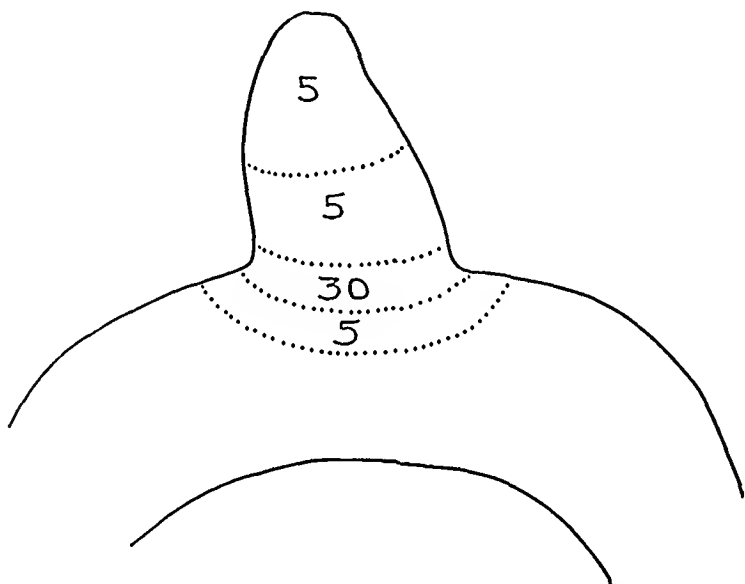


FIG. 3.—Diagram showing distribution of ulcers in 45 cases in which this was specified.

perforated cases were operated upon for appendicitis, peritonitis, intussusception or obstruction. However, whenever there is a so called "acute abdomen" associated with or preceded by the passage of a large amount of blood by bowel, exploration is demanded and a careful search for a Meckel's diverticulum should be made. (In one case in which a correct diagnosis was made it was not stated whether perforation had taken place.)

And so, in final analysis, the diagnosis of peptic ulcer in a Meckel's diverticulum, whether perforated or not, must depend upon the passage of large bloody stools and abdominal pain of variable degree. It should be remembered, however, that pain may be entirely lacking. When none of the more common causes which produce such symptoms can be found, an ulcerated diverticulum must be considered and operation is indicated. Roentgenologic examination has proven to be of practically no diagnostic assistance.

Treatment.—The procedure of choice in these cases is resection of the diverticulum with a portion of the adjacent ileum. Because the gastric mucosa

may occupy any portion of the diverticulum and because the ulcerations occur at the junction of the gastric and intestinal mucosa, these ulcers are situated in various parts of the diverticulum, *i.e.*, in the tip, neck or base of it, or outside of the diverticulum and in the ileum proper. Figure 3 shows the various locations of the ulcer in the 45 cases in which this was stated. Because so many of them occur at the base of the diverticulum and a few out in the ileum, it is always advisable to remove a cuff of ileum about the diverticulum when doing a resection.

Comment.—Unquestionably numerous cases of Meckel's diverticulum with ulceration have been encountered and operated upon that have not appeared in the literature. Meckel's diverticulum is no longer considered a surgical curiosity and if the whole truth were known a peptic ulcer in this location would probably not be a great rarity.

In all operations upon the gastro-intestinal tract, when the symptoms are not readily accounted for by the findings, a search should be made for a Meckel's diverticulum, particularly in children. Especially is this so when operating for appendicitis and when that organ is not found to be sufficiently inflamed to account for the symptoms. If this is done, the cause of many cases of so called idiopathic hemorrhage may be discovered, instances of unexplained peritonitis will be fewer, and many perforations of the diverticulum will be avoided.

Because any Meckel's diverticulum possesses numerous possibilities for serious trouble, and because a peptic ulcer in the location has such a strong tendency to perforate, resulting in a high mortality, any Meckel's diverticulum found at operation should be removed whenever possible.

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DISCUSSION OF THE PAPERS OF DOCTORS HORSLEY AND COBB

DR. JAMES M. MASON (Birmingham, Ala.).—As a Meckel's diverticulum is present only in 1.5 to 2 per cent of individuals, diseased condition of it will be only infrequently encountered. If it were present in 100 per cent of individuals, as is the appendix, it would probably have a position of greater importance in abdominal surgery than does that organ. Christie, from a study of 63 autopsies, classified three main types:

- (1) The umbilical fistula, 6.3 per cent.
- (2) Partial obliteration, with fibrous bands running from tip to umbilicus or some adjacent structure, 10 per cent.
- (3) Typical diverticulum given off from the antimesenteric border of the

ileum, lying free in the peritoneal cavity and presenting a closed distal extremity, 82.5 per cent.

Two other rare types are noted:

(4) Giant diverticula of bizarre form or shape, sometimes coming off from the mesenteric border of the intestine and developing between the leaves of the mesentery.

(5) The umbilical polyp either attached to the remains of the omphalomesenteric duct or entirely cut off from internal connections.

In types 1 and 5 the diagnosis is made by inspection. Type 2 causes the greatest number of obstructions. Type 3 gives rise to intussusception, volvulus and diverticulitis and is the type in which peptic ulcer is most frequently observed.

Deetz, in 1907, seems to have been the first to suggest the peptic nature of an ulcer in Meckel's diverticulum, when he removed a perforated diverticulum and found that it contained gastric mucosa. Though Hilgenreiner, in 1903, reported a case of intestinal hemorrhage from an ulcer in Meckel's diverticulum, he did not recognize its peptic nature; and Callender, in 1911, made the first observation of a bleeding ulcer of Meckel's diverticulum in which the presence of gastric mucosa was definitely confirmed by histologic examination.

Up to 1924, some seven cases of intestinal hemorrhage from Meckel's diverticula had been reported at irregular intervals; and between 1924 and 1932, some 26 additional cases had been reported.

It is probable that interest was stimulated by the studies of Schaetz who made serial sections of 30 diverticula, and found gastric mucosa in 23.3 per cent.

Since no series of symptoms points definitely to the presence of a Meckel's diverticulum, the possible relation of intestinal hemorrhage to ulceration of Meckel's diverticulum was a real diagnostic discovery.

When analyses of reported cases show that, in almost every instance, hemorrhage preceded perforation by considerable intervals of time, it gives the thoughtful surgeon an opportunity to explore a case of obscure abdominal discomfort before perforation of an ulcer has taken place, and with a mortality of zero, whereas in those cases operated upon after perforation showed a mortality of 43 per cent. I was much impressed by a paper by Hudson and Koplik, in 1932, in which they reported 32 cases of Meckel's diverticulum in whom 63 per cent showed intestinal hemorrhage, and in whom hemorrhage was the chief symptom in seven instances.

DR. THOMAS S. CULLEN (Baltimore, Md.).—For many years I have been greatly interested in remnants of omphalomesenteric duct. Sometimes when the cord comes away, a little red raspberry-like body is seen in the umbilical depression. If this yields to astringents it is granulation tissue, if it is firm and little affected by astringents, it is usually the persisting outer end of the omphalomesenteric duct. When cut away, a small, spurting vessel has to be controlled. The outer surface of this raspberry-like mass is covered by mucosa, identical with that of the small bowel, while the central portion consists of non-striped muscle.

Occasionally the omphalomesenteric duct persists throughout its entire extent. In such cases, when the cord comes away, a fecal fistula exists at the umbilicus. The intra-abdominal portion of the omphalomesenteric duct may be represented as a Meckel's diverticulum which extends to the umbilicus; by a Meckel's diverticulum of variable length with a free end or with a small cord extending from the end of the diverticulum to the umbilicus. In some instances a thin solid cord extends from the mesentery, across the small bowel,

to the umbilicus. This is the remnant of the vessels of an atrophied Meckel's diverticulum.

Occasionally a piece of pancreas is embedded in the tip of a diverticulum. In one case I reported the presence of gastric mucosa in the umbilical depression outside of the abdomen and independent of the abdominal contents. When the patient ate, gastric juice was secreted at the umbilicus. I have never noted gastric mucosa at or near the base of a Meckel's diverticulum. Doctor Cobb's observations are most valuable as well as most instructive.

One point I should like to emphasize—where a raspberry-like mass exists in the umbilical depression, and where this is covered over by intestinal mucosa, then the parents should be told that if at any subsequent time the child has the slightest sign of intestinal obstruction that the abdomen should at once be opened and a Meckel's diverticulum looked for.

As a matter of fact, I have grown to have a very great respect for a Meckel's diverticulum. In all cases of appendicitis where the findings at operation do not tally with the severity of the symptoms, I not only carefully examine the contents of the pelvis, but also examine for a Meckel's diverticulum.

DR. J. M. T. FINNEY (Baltimore, Md.).—Doctor Cobb's historic résumé is especially interesting. It is always well to know something of the medical and surgical worthies whose names are on our lips all the time, but about whom we know little or nothing. My interest in Meckel's diverticulum has been great since the first instance that I met with, which happened to be the first supposed appendicitis case upon whom I had ever operated. It had been diagnosed as an appendiceal abscess. The appendix, however, was found to be perfectly normal, but upon looking further a Meckel's diverticulum was discovered which presented a picture very similar to a traditional perforated appendix. Since that time, I have seen a number of similar cases. I can confirm the points that have been made, but will not take time to refer to all of them. I have seen such a relatively large number of Meckel's diverticula, that I now make it a routine practice to examine for them. Since we have been doing this routinely at the Union Memorial Hospital, we have been surprised at the number of cases we have found without symptoms.

Doctor Cobb called attention to the fact that this was usually a disease of early life, and was not a particularly fatal condition, hence a considerable number of these young people grow up, and it is found in a surprisingly high percentage of adults. I think we have reached the point where Meckel's diverticulum must be considered in every differential abdominal diagnosis, especially where hemorrhage and indefinite pain are present. I have noticed in one or two cases pain in the back, which has not been otherwise accounted for. We have not always made a positive diagnosis.

I was also interested in Doctor Horsley's presentation. I am not quite prepared, however, to be as radical as he is in performing partial gastric resections in these cases, and have always been partial to the pyloroplasty operation. Doctor Horsley has suggested an analogy to an anal fissure. In that case, if you thoroughly stretch the sphincter, you relieve the symptoms, which are due chiefly to muscular spasm, due to reflex irritation from the fissure. It seems to me that the same thing applies largely to ulcers of the pylorus. If you will put the pyloric muscle out of commission by excision of the ulcer and a segment of the pyloric muscle, the result will be satisfactory. I have just finished a case in whom a pyloroplasty was performed and a deep ulcer which was present excised, down to its floor. Sometimes one cannot excise the entire floor of the ulcer; we then treat it as we used to

treat old ulcers of the leg, by scarification, and then cover it over with mucosa. I have had the opportunity of observing some of these cases later pathologically. At any rate, you get a symptomatic cure of the symptoms, which is what interests the patient. I have found in the majority of instances that this has been all that is necessary. In a certain percentage of them, if after you have the pylorus open, you feel that you cannot reasonably expect a satisfactory result from the pyloroplasty alone, you can then proceed as Doctor Horsley has suggested.

DR. GEORGE A. HENDON (Louisville, Ky.).—I think it would very well represent the highest peak of refinement of clinical diagnosis to be able to distinguish between a pylorus that reaches out and grasps an ulcer, and an ulcer that in its progress invades the pylorus. I have met with some experiences that have changed my ideas considerably in regard to the treatment of peptic ulcer. I have now a series of 60 cases that have been treated upon the principle of complete and perfect rest of the stomach, which is made possible by a method of intravenous nutrition which I have devised. The patients treated in this way have remained well for periods up to seven years. Doctor Mayo used to say that it was time to operate when a patient had had about 12 medical recoveries. We now cure our ulcer patients after they have had at least four surgical recoveries.

I wish to say a word or two about gastro-enterostomy. I have found that when gastro-enterostomy works well the ulcer is transferred to the jejunum. When it does not work well the ulcer in the pylorus or duodenum remains as it was at the start. It is much like the old country doctor said at our state meeting. Someone asked him how he was and he said, "I am getting along pretty well, but I have a bad case of piles and a pretty bad rupture, and if I push the piles in the rupture comes out and if I push the rupture in the piles come out."

In my group of 60 cases I can report 90 per cent recoveries. My experience in this field bears out the importance of rest which was emphasized in Doctor Horsley's opening remarks. In one case a man had his gallbladder removed and a few rearrangements of his interior decorations. I put him on the rest treatment for ten days and he got so well cured that the cicatricial tissue growing in the ulcer area produced a complete obstruction of the pylorus. I did a gastro-enterostomy and he gained 75 pounds and has remained well ever since.

DR. RICHARD H. MILLER (Boston, Mass.).—In looking up our cases with acute abdominal symptoms at the Massachusetts General Hospital, we found 15 adults who did not present symptoms of ulcer. They were all diagnosed as acute appendicitis or strangulated hernia. In two of them an acutely inflamed diverticulum was present in the hernial sac.

I agree with Doctors Cobb and Finney that in any case of obscure, vague abdominal pain we should search for these diverticula. In every case of melena in young people the presumptive diagnosis of Meckel's diverticulum is sound. I believe, thirdly, that in every instance of acute intestinal obstruction in a young person, without an abdominal scar, the diagnosis of Meckel's diverticulum is reasonable.

DR. JOHN C. A. GERSTER (New York, N. Y.).—As to the statement about rest, at a meeting of the New York and Philadelphia Surgical Societies we reported two series of cases, one treated by bed rest in cases of ulcer of the lesser curvature, progress in which could be controlled by roentgenograms, and the other group placed on the Sippy diet. They ran about even. Some

have felt that putting a Levine tube in past the ulcer, and in that way putting the region at rest for a long time, was a good idea. Everyone admits that there are recurrences. The gastro-enterostomized patients may have relief for nine years and during the tenth develop a marginal ulcer. At the Harvey Society meeting last spring the director of the Cancer Research Section of the Middlesex Hospital in London stated that they had been able to obtain an extract from the middle lobe of the pituitary which if injected gave very good results.

DR. J. SHELTON HORSLEY (closing).—Doubtless my analogy of ulcer in the pyloric sphincter and fissure in ano is not entirely a happy one. It does tend to explain in a broad way the spasm, but a fissure in ano is open to inspection and treatment, whereas the other condition is not. Another thing is the marked tendency to recurrence in ulcer of the pyloric sphincter. There is also a tendency to bleed. In three of the cases referred to there were extensive hemorrhages. The ulcers on the posterior surface are very likely to erode the larger vessels. Pyloroplasty is a valuable operation but has a limited field. These are gastric ulcers, not duodenal. They are subject to cancerous change as well as recurrence. You may remember the work of Dragstedt and Vaughn in which they showed that the best way to produce a peptic ulcer in dogs was to put numerous sutures in the pyloric mucosa. In my early cases of pyloroplasty I sutured the pyloric mucosa and found quite a large percentage of recurrences at that point. The fact that these are gastric and not duodenal ulcers, that there is a marked tendency to bleed, to recur, and to undergo malignant change would seem to me to constitute definite indications for a type of gastrectomy that removes the tissues in this area, and preserves the function of the duodenum. There was no mortality in these cases.

OBSTRUCTION OF THE SMALL INTESTINE DUE TO FOOD PRODUCTS

F. WEBB GRIFFITH, A.M., M.D.

ASHEVILLE, N. C.

ELLIOT, in 1932, in reviewing the literature on this subject, stated that "Intestinal obstruction due to food is not a rare occurrence. A study of the available literature has revealed 39 cases reported since 1914, and all but ten in Germany or Austria. This is apparently traceable to the increased consumption of coarse foods in these countries as a result of the food shortage due to the World War. Only four instances have been reported in the United States during this time, and, as will be seen later, the diagnosis was not beyond question."

This paper is concerned with an analysis of these 39 instances in an attempt to elucidate the pathogenesis of this condition and to emphasize its importance. A case is reported of obstruction due to collards, proved by operation.

Of the 40 cases mentioned by Elliot, 13 were merely presumptive as they were not proven by operation or autopsy, and most of them recovered under conservative treatment. Of the remaining 27, five are eliminated because the obstruction was in the large bowel and therefore does not come under the scope of this paper, leaving 22 cases of obstruction of the small bowel due to food products.

In going through the literature I have found five others, which with my own makes six, or a total of 28 proven cases of impaction in the small intestine by food. Under the term food has been included bran, and also poppy seeds, which, as Elliot stated, were used in Germany to make soup and so called "ammunition" or "war" bread. The six cases not included in Elliot's list are, briefly, as follows:

(1) Roldan, of Montevideo, in 1929, reported a case of obstruction in a man aged 48, who had no upper teeth. A dried whole peach was removed from the ileum. Recovery.

(2) Herr, of Basel, in 1931, reported obstruction of the ileum by a single fig in a man aged 45. Ileostomy. Recovery.

(3) Davis, of Nashville, in 1931, removed a mass of bran the size of a hen's egg from the terminal ileum. Recovery.

(4) Zielke, of Leipzig, in 1933, operated for release of obstruction due to poppy seeds. Death.

(5) Block, of Philadelphia, in 1933, removed a mass of orange pulp from the lower ileum followed by enterostomy. Death from pneumonia ten days later.

(6) The author's case.

The list of foods which have been reported as causing obstruction comprises mushrooms, figs, beans, poppy seeds, grapes, bran, orange pulp, "ammunition bread," oats, corn, popcorn, gooseberries, cherries (with stones), raisins, sauerkraut, potatoes, a mixture of peas and potatoes, a mixture of peas and fruit, a whole dried peach, collards. Mushrooms headed the list as the cause in five instances.

In the 28 cases of proven impaction in the small bowel, pathology of the intestine, which might act as a predisposing cause, was found in only three cases. In one there was a tuberculous stricture in the lower ileum. One had been operated upon 20 days previously for "spermoblastoma" and adhesions had caused a partial obstruction. One had had an entero-anastomosis five years previously. In all three cases the bolus which had accumulated proximal to the obstruction consisted of mushrooms. With the exception of these three cases, the obstruction was in the terminal ileum. In only one case was the correct diagnosis made before operation. A boy, in a contest, had eaten a huge quantity of unseeded cherries. In practically every case the symptoms were simply those of a partial or complete obstruction of the small bowel.

The ingestion without proper mastication, in short, literally gulping down, a huge quantity of food rich in fiber, throws into the intestine more than it can handle. It is not surprising that under such conditions impaction occurs. It is remarkable that it does not occur more frequently.

In the 28 cases there were 13 deaths, and abstracts of two cases did not give the result. Therefore there was a known mortality of 46 per cent and possibly higher.

CASE REPORT

Mrs. J. M., aged 26, had been married five years and had one child, aged four. Her menstruation had always been normal. No leukorrhea, no urinary symptoms, no previous operation, bowels regular.

Present Illness.—Three days before admission, patient ate a large amount of collards for dinner and another large amount for supper. At 9 P.M. she took a dose of castor oil, not because of abdominal symptoms, but because she had coryza and a severe headache. At 2 A.M. she was awakened with severe abdominal pains which were intermittent and described by her as simulating "labor pains in region of naval." She began vomiting, which was repeated intermittently until admission to the hospital three days later. Several hypodermics of morphia were given during the interim. The abdominal pains, however, continued to become more severe. Her bowels had moved fairly well the day previous to admission and an enema had given good results. She was examined 54 hours after the onset of symptoms.

Physical Examination.—Patient does not look to be desperately ill, but is obviously suffering from rather severe abdominal pains. Heart, lungs and extremities normal. Abdomen is uniformly and moderately distended. There is no marked tenderness anywhere in the abdomen, nor is there any great degree of muscle spasm or rigidity. Over the right lower quadrant there is slight but definite tenderness on moderate pressure. Also the lower right rectus is somewhat more rigid than the rest of the abdomen. Pelvic examination shows the uterus and adnexa to be normal and no tenderness in the vaginal vault. The leukocyte count was 10,200, 79 per cent polymorphonuclears. The urine was negative except for a trace of albumin.

Preoperative Diagnosis.—Subacute appendicitis with obstructive symptoms.

Operation.—Under ether a right rectus incision was made. The appendix was adherent and was removed. In the ileum about one-half inch from the cecum and extending proximally about eight inches could be felt an elongated, sausage shaped, soft, putty-like mass, about the size of a banana. A rubber clamp was placed on the ileum proximal to the mass and the ileum opened with the cautery. The semisolid mass was removed and found to be composed almost entirely of undigested collard leaves matted together. The total amount of this mass after removal was estimated to be about the size of a small orange.

An enterostomy was done. Hypodermoclysis was started following the operation. The patient continued to vomit throughout the day, the ejecta having a definite fecal odor.

Nasal suction drainage was established. At the end of 48 hours there was still only a very slight drainage through the enterostomy tube. A small amount of salt solution was then forced through the enterostomy tube after which fecal drainage became freer, followed by the expulsion of several pieces of collard.

After that the distention disappeared, the patient making an uneventful recovery, leaving the hospital three weeks from the time of the operation with the fecal fistula almost closed.

DISCUSSION.—DR. J. A. CRISLER, JR. (Memphis, Tenn.).—In connection with food impaction of the small intestine, I wish to report briefly the case of a man, aged 75, who was operated upon 11 months ago for symptoms of partial intestinal obstruction. A mass resembling a gallstone, but actually a fecal mass, was removed from the jejunum. Nothing more was found and an enterostomy was performed. The patient made a complete recovery but six months later was readmitted to the hospital for acute intestinal obstruction. Operation at this time revealed a segment of small intestine, about eight inches long, edematous, distended, packed with food particles, and feeling not unlike a soggy bean bag. An adhesion of the jejunum to the parietal peritoneum at the site of the previous enterostomy had narrowed the lumen of the intestine sufficiently to hold back this large bolus of food. After freeing the adhesions the food particles were evacuated from the edematous segment of the intestine. The patient again recovered and afterwards told us that he had been eating cantaloup without using his false teeth.

DR. L. WALLACE FRANK (Louisville, Ky.).—I wish to report experiences with two similar cases. In neither was there a history of the type of food taken. Both patients had symptoms of partial obstruction. In the first case there had been obstruction for four days. At operation a mass was found in the lower end of the jejunum which was thought to be a gallstone. The gallbladder was examined but showed no evidence of disease. An incision was made in the intestine, the mass was removed and found to be inspissated fecal material containing a good deal of fiber. The patient died four days later from peritonitis.

The second case was seen after the symptoms of obstruction had existed for 24 hours. Inasmuch as the first patient had died of peritonitis, and thinking possibly that the sutures in the intestinal wall had sloughed, I decided to resect the obstructed loop rather than to remove the obstructing material. The obstruction was in the midpart of the jejunum and a resection of six inches of intestine was done followed by end-to-end suture. Examination of the excised loop proved the obstructing material to be inspissated intestinal content, again containing a good deal of fibrous material. Pathologic examination of the intestinal wall revealed thrombosis of all the vessels in it. This finding explains, I think, the cause of death in the first patient, namely,

sloughing in the suture line due to impaired circulation in the intestinal wall. In the future, should we be so fortunate as to see another such case, I certainly intend to perform a resection of the involved loop rather than a simple removal of the obstructing mass with subsequent closure of intestine.

DR. ROBERT L. RHODES (Augusta, Ga.).—I would like to recite an instance of food bolus in the intestine cured by nonoperative measures. Seven years ago, following the visit to our community of an advocate of certain dietary measures, including the use of bran, the patient in question thought that if a little was good, a lot would be better, and consumed an entire box of bran within 24 hours. She had vomiting and abdominal pain, and when I saw her there was a mass which could be felt over the region of the terminal ileum. Her bowels had not moved. Her past history was negative. Under hot turpentine stupes, stopping everything by mouth and giving repeated enemata, with an effort to retain the fluid as long as possible, and judicious massage, by a careful nurse, kneading the mass, she succeeded in disseminating it so that the patient was relieved after about 24 hours.

DR. WALLER O. BULLOCK (Lexington, Ky.).—I would like to add one case to this series, although I hesitate because in some respects it is a source of mortification, but in others it was fortunate. The patient was suffering from a gastric ulcer and we were in doubt as to whether carcinoma was present or not. At operation I dissected the pylorus away from the pancreas. A specimen was examined pathologically at the time and pronounced benign. I therefore performed a pyloric resection and made an anastomosis with the duodenum by an end-to-end procedure; the patient recovered and went home. Three months later he returned with signs and symptoms of acute intestinal obstruction. We operated immediately and found a mass in the jejunum. The jejunum was opened and the mass extracted. It turned out to be a phytobezoar composed of persimmon seeds. A postfacto history revealed the fact that he had eaten persimmons about a year before. He made a complete recovery following operation.

SHOULDER AND CLAVICULAR PAIN IN APPENDICITIS

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IN 1923, my attention was first called to a case of appendicitis in which pain was referred to the region of the shoulder and clavicle. The second case was seen 11 years later. Recently 485 questionnaires were sent out relative to this subject. Three hundred fifty-one replies were received, among which three instances were reported. A complete review of American and foreign literature from 1920 to 1935 revealed six additional cases, bringing the total up to 11.

Both Siegmund Erben¹ and Jonas² mention the fact that they have observed right shoulder pain in appendicitis, but they do not give any case records. Zachary Cope³ reports two cases of appendicitis where the pain was referred to the right shoulder and clavicle about 15 hours after the onset of symptoms. At operation the appendix was found to have ruptured and there was beginning peritonitis. He states that it is seldom that phrenic shoulder pain is a symptom in uncomplicated appendicitis. He has been able to find references to only two such cases in the continental literature. In a review of 344 cases of appendicitis, David Hilton⁴ reports one case where the pain was referred to the region of the right shoulder.

In 1929, Sir Bruce-Porter⁵ reports the history of a man, aged 51, who consulted him on account of pain above the right nipple area, of five years' duration. At times this pain was quite severe. During the course of his examination, pressure was made over the region of the appendix, and the patient immediately placed his hand above his right nipple and cried out, "Why, that is my pain," and each repetition of the pressure over the appendix produced an exacerbation of the pain above the nipple. At operation, the appendix was found lying in the pelvis and showed evidence of both acute and chronic inflammation. When the patient recovered from the anesthetic his pain above the nipple had disappeared, and did not return.

Sir Bruce-Porter reports a second case of a young officer who consulted him on account of pain above the left nipple, which the patient attributed to heart disease. Further examination with investigation of his digestive tract revealed chronic appendicitis, and removal of his appendix cured his precordial pain. Irving Gray⁶ reports a case of chronic appendicitis with pain referred to the left shoulder. After removal of his appendix, there was no recurrence of his shoulder pain. Fred W. Bailey⁷ reports a case of appendicitis with pain referred to the right shoulder and clavicle. The appendix was acutely inflamed, but was free from adhesions. The patient was relieved of the shoulder pain following operation. Francis Reder⁸ reports two cases

of appendicitis where the pain was referred to the left supraclavicular and acromial regions and was relieved following appendectomy.

CASE REPORTS

Case 1.—Miss H. S., aged 16, was admitted to St. Luke's Hospital August 2, 1923. On the day before her admission, she was suddenly seized with a sharp pain in the

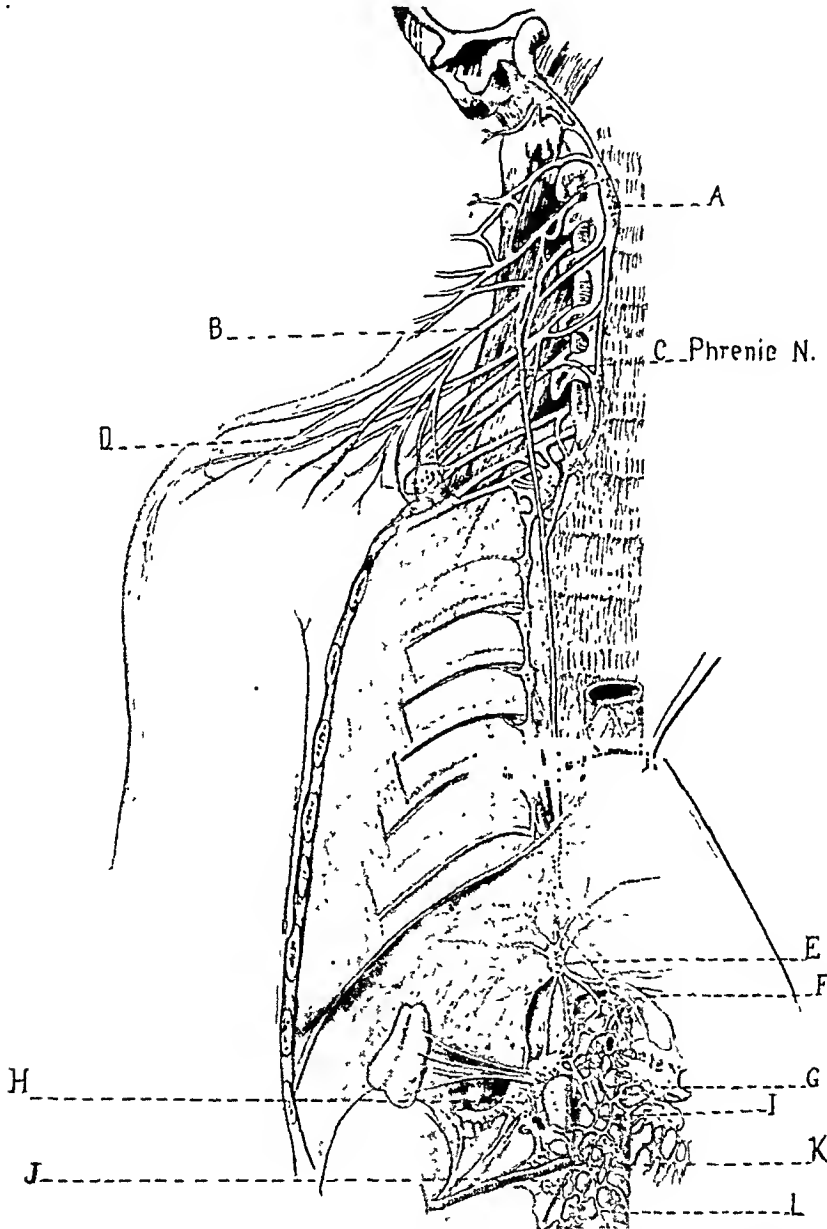


FIG. 1.—Drawing showing the cervical plexus and the eutaneous distribution of the fourth and fifth cervical nerves, also the origin and distribution of the phrenic nerve. (A) Superior cervical sympathetic ganglion. (B) Fourth cervical nerve. (C) Phrenic nerve. (D) Fifth Cervical nerve. (E) Diaphragmatic ganglion. (F) Diaphragmatic plexus. (G) Left semilunar ganglion. (H) Right semilunar ganglion. (I) Celiac plexus. (J) Superior mesenteric ganglion. (K) Superior mesenteric plexus. (L) Aortic plexus.

epigastrium which was referred to the region of her right clavicle, and extended over the right shoulder and down the side of her arm. This was associated with nausea and vomiting. The shoulder pain was increased when she was flat in bed and was partially

SHOULDER PAIN IN APPENDICITIS

relieved when her legs were flexed. She had no pain in the right iliac fossa, but had definite tenderness over the region of her appendix, pressure over which caused severe pain over the region of the clavicle and shoulder. There was beginning rigidity of the right rectus muscle, and hyperesthesia of the right shoulder. The white count was 18,600, with 89 per cent polymorphonuclears. The urine was negative. Examination of her heart and lungs was normal.

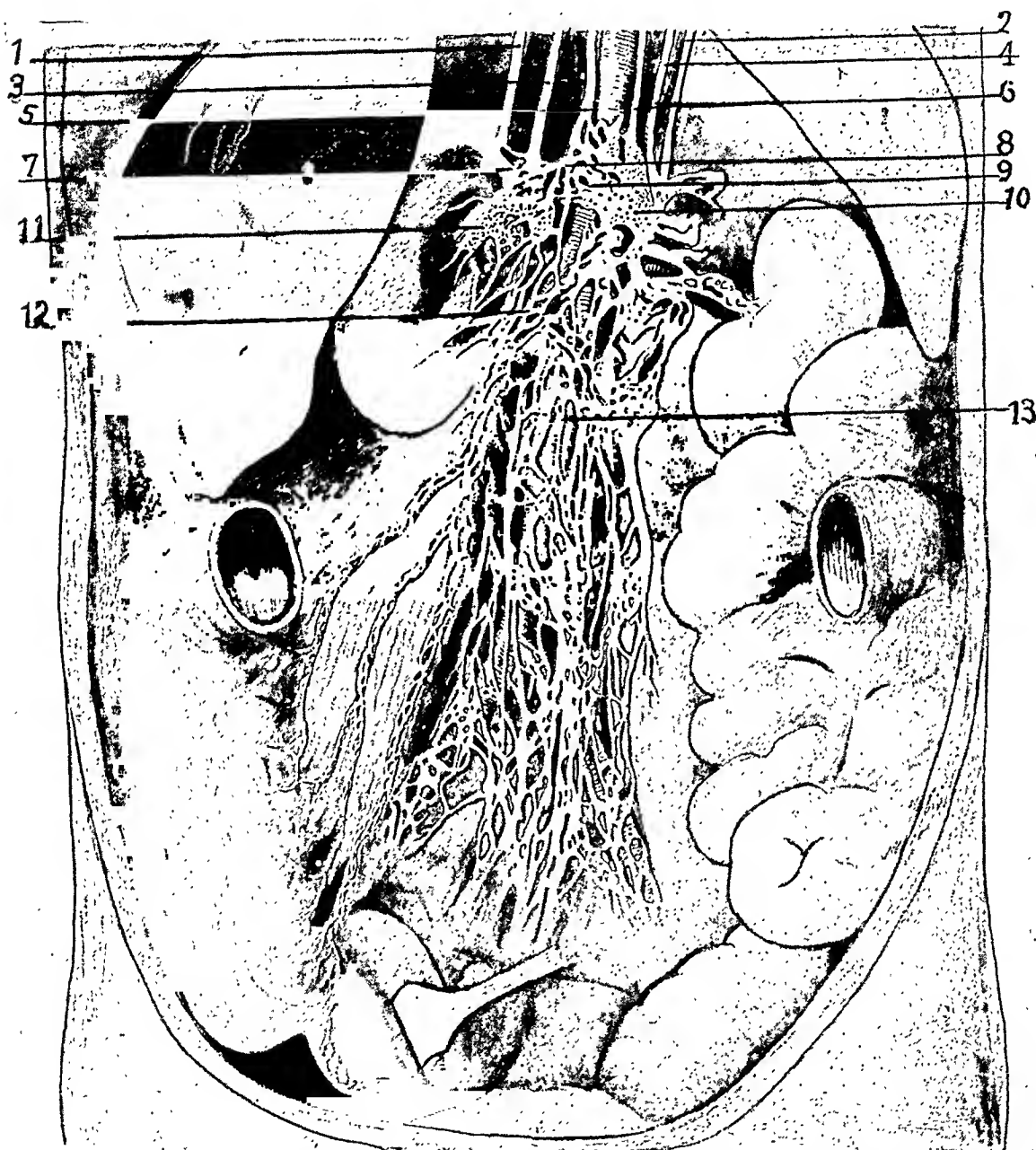


FIG. 2.—Drawing showing the nerve supply to the appendix and the communication between the superior mesenteric plexus and the phrenic nerve. (1) Right phrenic nerve. (2) Left phrenic nerve. (3) Right great splanchnic nerve. (4) Left great splanchnic nerve. (5) Right vagus nerve. (6) Left vagus nerve. (7) Diaphragmatic ganglion. (8) Diaphragmatic plexus. (9) Celiac plexus. (10) Left semilunar ganglion. (11) Right semilunar ganglion. (12) Superior mesenteric plexus. (13) Aortic plexus.

Operation revealed an acutely inflamed appendix that was bound down by dense adhesions in the right iliac fossa. When the patient regained consciousness, she stated that she no longer had any pain in the region of her shoulder.

Case 2.—Mrs. J. B., aged 34, was admitted to St. Luke's Hospital March 19, 1934. While she was eating her dinner she was suddenly seized with a severe pain above the right clavicle which radiated upward toward her neck, and over the side of her shoulder

and down the side of the arm. This pain was associated with nausea and vomiting. The pain in her shoulder continued and she vomited several times during the evening. The nausea subsided that night, but the pain remained constant. A diagnosis of cervical neuralgia was made and her shoulder was baked with an infra-red lamp, but without relief.

Toward the evening of the second day, she had a rather severe pain in the epigastrium with radiation of pain across her chest and over the right shoulder. Dr. L. P. Gay sent her to the hospital with a diagnosis of an acute surgical abdomen. Examination showed definite rigidity of the entire right side of the abdomen and very acute tenderness over the appendiceal region. Whenever pressure was made over the appendix, the pain in her shoulder was increased. There was hyperesthesia about the distribution of the fourth and fifth cervical nerves. The heart and lungs were normal. The urine was normal except for a few white blood cells. White blood count was 21,400, with 92 per cent polymorphonuclears. Temperature, 99.8° F.; pulse, 104.

Operation revealed a very acutely inflamed appendix that was lying free, just above the brim of the pelvis. As soon as the patient regained consciousness, she stated that the pain across her chest and about the region of her shoulder had been relieved.

Relief of the pain in the upper chest and shoulder region following appendectomy indicates that the pain was caused by inflammation of the appendix, consequently it was referred pain. Since the area to which the pain was referred is supplied by the third, fourth and fifth cervical nerves, the afferent impulses arising at the site of the inflammation must have entered the spinal cord in the corresponding cervical segments. The only nerve connected with this segment of the spinal cord, which includes afferent fibers that reach the abdomen, is the phrenic. Consequently these must be regarded as cases in which the pain was referred via the phrenic nerve.

The subject of referred pain has always been an interesting one. It has been definitely proven by the work of Head,⁹ Ross¹⁰ and others, that the cutaneous distribution of pain referred from a visceral organ falls within the area of distribution of the nerves, which are connected with the same segments of the spinal cord, as those through which the impulses travel from the diseased viscus. In the cases in question, the pain was in cutaneous areas that are supplied by nerves which arise from the same spinal segments from which the phrenic nerve takes its origin. The supraclavicular and acromial branches of the cervical plexus supply this area, and it will be noted that the phrenic is also a branch of this plexus. The pain impulses originating in the appendix must have been conducted by phrenic nerve fibers which traverse the celiac and superior mesenteric plexuses.

The phrenic nerve is an internal muscular branch of the cervical plexus, arising very largely from the fourth cervical nerve, and receiving twigs from the third cervical and occasionally from the fifth. It contains both motor and sensory fibers, in the proportion of about 2 to 1.

It communicates directly in the lower part of the neck with either the inferior or middle cervical sympathetic ganglion, and just above the diaphragm it receives a twig from the sympathetic cord. The superior cervical sympathetic ganglion sends gray rami communicantes to the first, second, third and fourth cervical nerves and hence to the phrenic; and the ganglion of

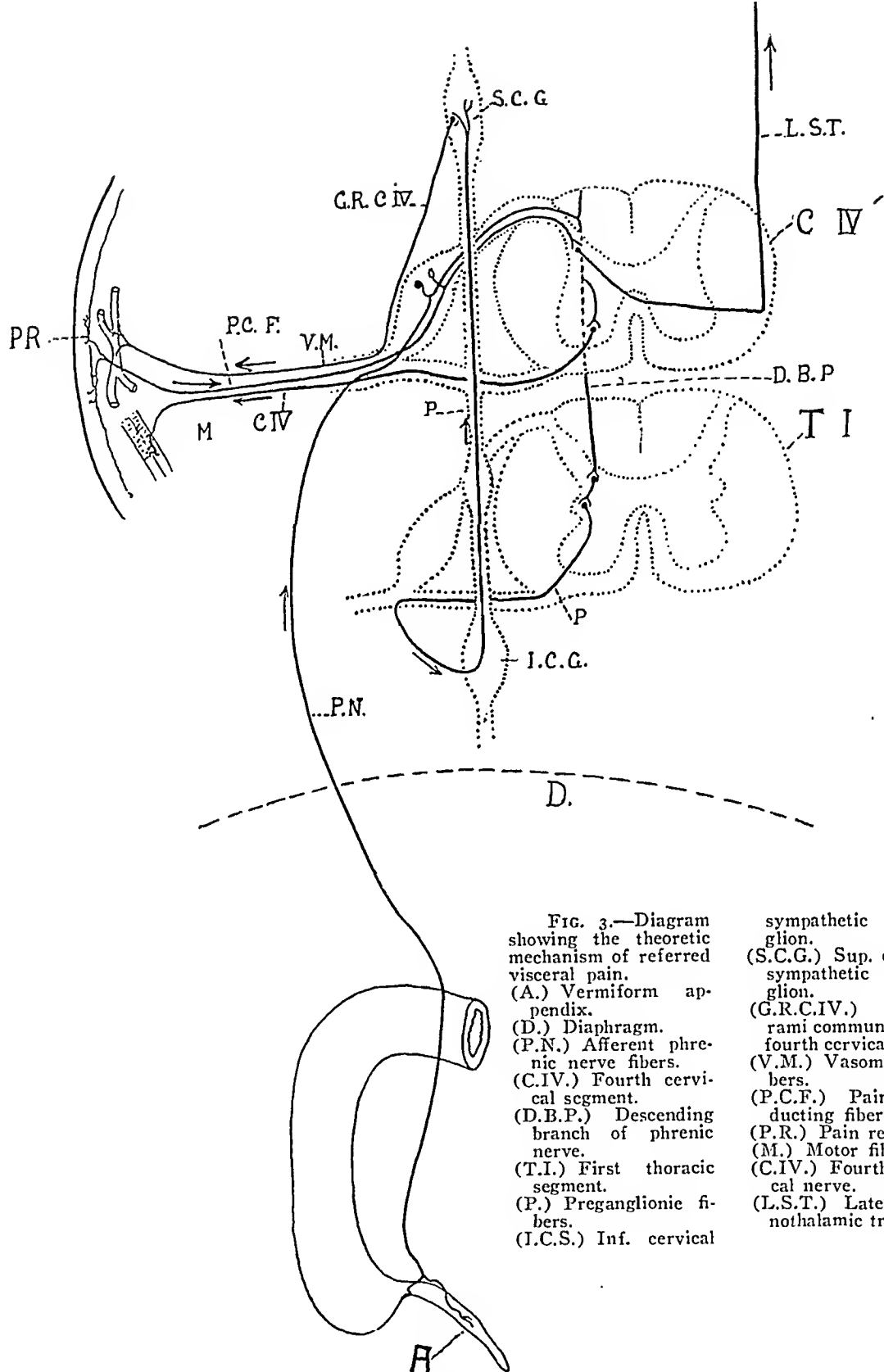


FIG. 3.—Diagram showing the theoretic mechanism of referred visceral pain.
 (A.) Vermiform appendix.
 (D.) Diaphragm.
 (P.N.) Afferent phrenic nerve fibers.
 (C.IV.) Fourth cervical segment.
 (D.B.P.) Descending branch of phrenic nerve.
 (T.I.) First thoracic segment.
 (P.) Preganglionic fibers.
 (I.C.S.) Inf. cervical

sympathetic ganglion.
 (S.C.G.) Sup. cervical sympathetic ganglion.
 (G.R.C.IV.) Gray rami communicantes, fourth cervical nerve.
 (V.M.) Vasomotor fibers.
 (P.C.F.) Pain conducting fibers.
 (P.R.) Pain receptors.
 (M.) Motor fibers.
 (C.IV.) Fourth cervical nerve.
 (L.S.T.) Lateral spinothalamic tract.

EXPLANATION OF FIG. 3.

The afferent pain impulses originate in the appendix (in these cases), and travel upward over the phrenic fibers through the fourth cervical nerve and make reflex connections in the spinal cord with ordinary motor neurones, and also with preganglionic neurones. Since there are no preganglionic neurones at the fourth cervical level, the impulse must travel downward through the spinal cord over the descending branch of the phrenic nerve to the level of the first thoracic segment; where reflex connections are established with preganglionic neurones. The impulse then continues through the preganglionic fibers and enters the inferior cervical sympathetic ganglion and continues upward to the superior cervical sympathetic ganglion, where synaptic connections are effected with sympathetic motor neurones, and the impulse continues peripherally over the gray rami communicantes of the fourth cervical nerve. Whenever reflexes pass through these sympathetic neurones, they produce vasoconstriction, which results in the liberation of a chemical substance which stimulates the pain receptors in the skin. These impulses are then conducted centrally over the pain conducting fibers of the fourth cervical nerve and are transmitted to the neurones in the gray matter of the cord which join with fibers that ascend in the lateral spinothalamic tract to consciousness; which is the ordinary ascending conductive pathway for impulses of pain.

the trunk of the vagus is sometimes connected by means of a tiny nerve with the loop between the first and second cervical nerves.

The branches of the phrenic nerve are the pleural, pericardial and terminal. According to Gray's¹¹ anatomy, branches have been described as passing directly to the peritoneum. The terminal branches differ to some extent on the two sides. The right phrenic is divided into two branches, an anterior and a posterior. The anterior branch sends five or six fine twigs to the diaphragmatic musculature. The posterior branch passes through the central tendon of the diaphragm and gives off muscular branches and is continued as the phrenico-abdominal branch.

The phrenico-abdominal branch breaks up, and some of its fibers enter the diaphragmatic ganglion, while others unite with branches of the celiac plexus to form the diaphragmatic plexus. This connection of the phrenic nerve with the celiac plexus affords a pathway through which afferent fibers of the phrenic may, in some cases, reach the superior mesenteric plexus to be distributed to the intestine including the cecum and appendix, through the nerves accompanying the superior mesenteric artery and its branches.

The left phrenic nerve pursues a similar course, but divides into three branches—(a) anterior, (b) lateral, and (c) posterior. The anterior and lateral branches supply the diaphragm. The posterior branch also gives a branch to the diaphragm and is then continued as the phrenico-abdominal branch, sending branches to the left semilunar ganglion, and celiac plexus.

There is a direct communication between the diaphragmatic plexus, the semilunar ganglion, the celiac plexus, and the superior mesenteric plexus. The superior mesenteric plexus is continuous above with the celiac plexus and with the aortic plexus below. The fibers are derived from the semilunar ganglion, the celiac plexus and the right vagus nerve and are supplied to the same portion of the intestinal tract that receives its blood supply from the superior mesenteric artery. Since both the phrenic nerve and the superior mesenteric plexus communicate with the semilunar ganglion and the celiac plexus, and since both receive filaments from the right vagus nerve, it seems only fair to assume that there is a communication between the phrenic nerve and the branches of the superior mesenteric plexus that supply the appendix.

A simple anatomic explanation for clavicular or shoulder pain in appendicitis has been offered, but this is not the whole explanation for such an unusual referred pain, and there must be some other factor or factors present, such as anomalous direct communication between the superior mesenteric plexus and the phrenic nerve, or an anomalous connection through the sympathetics, the splanchnics or the vagus nerve, otherwise this symptom complex would occur more frequently.

CONCLUSIONS

(1) Pain that is referred to the shoulder and clavicular regions in appendicitis is a rare symptom.

(2) This pain ceases immediately after removal of the appendix.

(3) Pain in the shoulder and clavicular regions due to appendicitis can be explained only as referred pain resulting from impulses arising from the appendix and conducted through the phrenic nerve.

(4) A possible explanation of this symptom complex is offered by an anatomic diagram, showing a communication between the phrenic nerve and the terminal branches of the superior mesenteric plexus.

(5) Distribution of phrenic fibers to the appendix must be regarded as anomalous, otherwise this symptom complex would occur more frequently.

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DISCUSSION.—DR. HUBERT A. ROYSTER (Raleigh, N. C.)—In 1927, I made a collection of signs of appendicitis, 14 in number. I arranged them alphabetically, and am glad to add another sign under the letter "M." This is Mastin's sign. Some of the signs are purely reflex. Others are toxic in origin, proving that the appendix is the focus of infection. The reflex is seen in areas in which we can reproduce the pain, for example, in the epigastrium, at which site the patients complain in acute attacks. This sign of Doctor Mastin's is in the same category. The reflexes are centered in the midbrain and the subconscious feeling is produced accordingly. In the other type of acute pain due to absorption, perhaps, in disease of the appendix, there are headache, trigeminal neuralgia, sciatica, and so on. These signs are especially valuable, it seems to me, in the intervals of so called recurrent or relapsing cases. They can be elicited in various ways. Rolling to the left side will reproduce the pain in the appendix. I think distinction should be made between the neurogenic cases and those of toxic origin. The toxic origin is so important that I have called attention to the three T's, teeth, tonsils and "tummy," the latter meaning foci of disease in the abdominal cavity, which are of equal importance with the first two.

DR. JOE V. MEIGS (Boston, Mass.)—We have had a few cases of pain in the shoulder following hemorrhage from a ruptured follicle or corpus luteum of the ovary. I wonder if this pain could not have been reproduced by the method of nerve reference described by Doctor Mastin.

DR. GUY L. HUNNER (Baltimore, Md.)—I think we should bear in mind that renal pain is sometimes located in the chest and we must take it into consideration in diagnosing this group that Doctor Mastin has spoken to us about. Usually if the shoulder or scapular pain is of very acute character, of course we have to differentiate it more frequently from gallbladder pain. If it is of more chronic and of less acute character we often think of heart trouble if it is on the left side, or of tuberculosis if it happens to be on one or both sides, particularly if there is a little increase of temperature, as there is in some of the renal absorption cases. The way in which it might be mistaken for the pain of appendicitis is that on palpation of the tender ureter as it crosses the pelvic brim, unless you have both the appendix and the ureter in mind, you may conclude that it is the appendix. I have had three renal cases who had pain referred to the chest and had various periods of confinement in tuberculosis sanatoriums, although there was no positive evidence of tuberculosis. They were sent on the strength of the chest pain and a low degree of fever which was more or less continuous. These cases clear up when relieved of back pressure on the kidney.

DR. E. V. MASTIN (closing).—In answer to Doctor Meigs' question, I can see no reason why the pain mentioned could not be traced over a similar arc. The afferent fibers would have to travel through the hypogastric, aortic and semilunar plexuses, through the phrenic nerve, in the same way which I have described.

One reason that prompted me to present this paper was the hope that physicians would be on the lookout for this symptom complex, as I am sure there must be many more cases in which it is present, but overlooked.

Copps and Coleman, in 1922, reported the results of their experiments in cases where a trocar was inserted through the abdominal wall for relief of ascites. They next passed a curved wire and stimulated various parts of the peritoneum and the under surface of the diaphragm. When the diaphragm was stimulated, and hence the branches of the phrenic nerve, the pain was referred to the shoulder tip, but when the other areas of the peritoneum were stimulated, the pain was localized very closely to the point of stimulation. These results have been duplicated by other observers.

Morley has done a great deal of interesting work on referred visceral pain and has shown that when the terminal branches of the fourth and fifth cervical nerves are anesthetized, the shoulder tip pain does not occur.

SERIOUS COMPLICATIONS FOLLOWING NEGLECTED CHOLELITHIASIS

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BUT one phase of hepatic disease will be considered, *i.e.*, cholelithiasis, and my observations will be limited to the consideration of the serious complications of this condition, and suggestions for their prevention. Problems of diagnosis and treatment are necessarily omitted, as the entire object is to emphasize two pertinent points: (1) that symptomless gallbladder pathology is a rarity; (2) the infected gallbladder with gallstones is never cured by duodenal drainage nor by medical therapy. Its pathology is progressive and potentially dangerous to life and health, and merits the recognition of primary symptoms, early diagnosis and preventive surgery. To approach control of serious surgical disease, we cannot ignore the demand of early recognition. This will not be practically available without the interested cooperation of the patient, physician and surgeon.

Although it is not within the scope of this presentation to discuss the fundamentals of gall tract disease, its symptomatology, pathology, or treatment, it would be discourteous to write even the briefest monograph on this subject, or any part of one, without giving full credit to the pioneers in gall tract study such as Entmuller, Malpighi, Van der Wiel, Muller and Jean Louis Petit, and to the masters of the nineteenth century, among whom were Langenbach, Marion-Sims, Kocher, Tait and Keen.

At the opening years of the present century, our knowledge of gallbladder disease rested chiefly upon rather crude assumptions. As pointed out by Judd, the gallstone was considered the "bandit" of gallbladder disease, but conservation of the gallbladder, however deeply infected, was deemed essential. Within 35 years, through the masterly surgery, persistent experimentation, pathologic and bacterial studies of Mayo-Robson, Deaver, Moynihan, W. J. Mayo, C. H. Mayo, Rowntree, Mann, Rosenow and many others, we are now aware that an infected gallbladder is a menace to health; does not spontaneously heal without residual pathology; promotes and fosters formation of stones, pericystic adhesions and liver dysfunction; and may be removed without detriment to health. As stressed so earnestly by Judd and others, the need of continuous cooperation between the laboratorian, the internist and the surgeon is paramount if we hope to control disease. By the brilliant work of Mann, Graham, Rowntree, Van den Bergh and others, we are approaching a working knowledge in early diagnosis and the effect of disordered liver function upon the blood stream, pancreas, stomach, intestines and metabolic activities. A satisfactory training in pathology and ther-

apy is best secured by a thorough knowledge of the physiology of the organs involved. Through these pioneers and their co-workers, in their various fields of research, we have been furnished a broader knowledge of the function and physiology of the liver and its contiguous organs.

It is customary to rate our estimate of the gravity of a disease by the number of deaths which occur. Should we not instead predicate such an estimate upon the length and degree of morbidity, with its violent strain upon vital functions, economic distress, pain, discomfort and fear, rather than upon final and complete dissolution? Defeat of death by operation in a stage which assuredly leaves a residue of permanent disability dare not challenge comparison with the result following an early diagnosis and operation before definite damage is sustained, particularly in a disease which we are persuaded is surgical from the period of the initial gallbladder infection. Each case so conducted, before hepatic function is disturbed, obviously banishes most of the morbidity which surely follows neglect, such as cholangitis, chronic hepatitis, biliary obstruction, perforation, abscess, peritonitis, crippling adhesions, pancreatic disease and possibly cancer.

At no age in life are gallstones harmless, and a neglected case is always a menace to the well being of the carrier. Two hundred cases were reviewed, the ages ranging from 28 to 86, with symptoms of gallbladder disease present and active from five to 60 years. Periods of morbidity were variable and the complications were uniformly serious (Table I).

TABLE I

COMPLICATIONS ENCOUNTERED IN TWENTY-EIGHT CASES OF CHOLELITHIASIS

Hydrops.....	2
Hour-glass gallbladder.....	2
Gallbladder completely impacted.....	3
Single stone, cystic duct impaction with obstruction.....	5
Gallbladder stones and cystic duct impaction with obstruction.....	13
Gangrenous cholecystitis with gallstones.....	6
Perforation with abscess.....	12
Perforation into liver abscess containing stones.....	3
Common duet stones with obstruction.....	3
Common duet occlusion (stones, abscess, edema, Ca.).....	9
Cancer involving cystic duct area.....	2
Mortality (28 cases reviewed; 2 Ca. lived 6 months and 1½ years respectively. One died 3rd postoperative day, cardiorenal)	
One case only, free of adhesions	

Each of these patients was of necessity subjected to a serious operation, long tedious hospitalization and subsequent morbidity out of all reasonable proportion to that which would have attended an earlier diagnosis and lowered surgical risk during the period of safety.

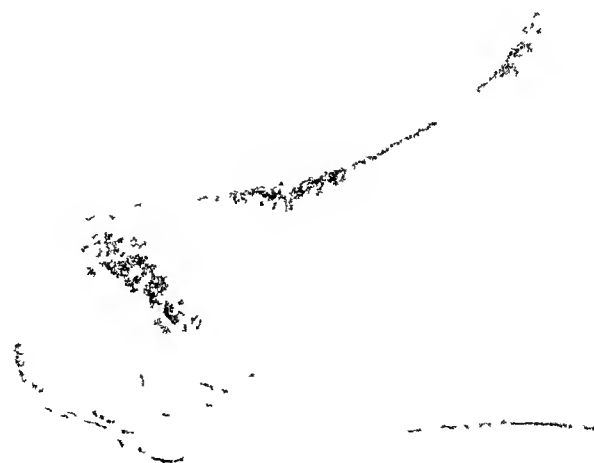
Fig. 1 (Case 6) —Low glass gallbladder. Impacted cystic duct stone.

PA. Conrath



Fig. 2 (Case 7) —Impacted cystic stone Beginning emphysema.

PA. Conrath



ABSTRACTED HISTORIES OF TWENTY-EIGHT CASES WHICH PRESENTED SERIOUS
COMPLICATIONS

Case 1.—Mrs. L. F., aged 60. Had been semi-invalid for nearly 30 years; continuous epigastric distress. A typical psychoneurotic. Had four previous operations. Iodickon test revealed diseased gallbladder with stones.

Operation revealed liver margin adherent to diaphragm, numerous adhesions with duodenum entirely covering gallbladder. Many gallstones removed by cholecystectomy. Entirely relieved of distress and nervous symptoms.

Case 2.—Mrs. H. W., aged 48. First attack of upper abdominal pain 20 years ago, intermittent attacks of indigestion since. Final attack progressive. Patient had developed severe cardiovascular-renal disease with hypertension.

Operation revealed two large stones completely filling inactive gallbladder. Marked improvement followed cholecystectomy.

Case 3.—J. W. H., aged 51. Suffered acute attack of epigastric colic 27 years ago, with classic symptoms indicating gallbladder infection. Practiced medicine for 25 years with frequent attacks of upper abdominal pain, nausea and vomiting, jaundice not marked except for few days following each attack.

Operation revealed small contracted gallbladder, fixed to transverse colon and duodenum, containing single large impacted gallstone.

Case 4.—Mrs. R. L., aged 30. Attacks of indigestion, with pain in gallbladder region for several years. Final attack progressive.

Operation revealed gallbladder filled with stones, attached to and compressed by a tumor lying between the cystic area and the duodenum. The tumor peeled out readily, consisting of pancreatic tissues, non-malignant. Numerous adhesions between hepatic flexure and duodenum and gallbladder.

Case 5.—A. S., aged 55. Indigestion with nausea and dull pain in gallbladder region for several years. Treated continuously for indigestion.

Operation revealed infected gallbladder with cystic duct firmly impacted by large mulberry stone. Numerous adhesions.

Case 6.—Mrs. A. H. L., aged 32. Under treatment for eight years for peptic ulcer. Appendectomy nine years ago. Frequent attacks of epigastric pain, with vomiting and flatulence. Not responding to medical treatment.

Operation revealed hour-glass contraction distal to ampula of gallbladder, which contained an impacted stone. Numerous fibrous adhesions to duodenum and liver.

Case 7.—Mrs. R. M., aged 30. Treated for indigestion for over five years. Final attack unrelieved.

Operation revealed huge hydrops of gallbladder with single impacted stone of cystic duct, which showed area of beginning gangrene. Cystic duct distal to stone completely occluded.

Case 8.—Mrs. N. H., aged 55. Had suffered intermittent attacks of epigastric pain over 25 years, with slight icterus, which faded rapidly. Recent attack progressive.

Operation revealed huge gallbladder filled with faceted stones, with one large stone obstructing cystic duct compressing the common duct. No pericystic adhesions.

Case 9.—Mrs. R. M., aged 51. Gastric symptoms for 20 years. Frequent attacks of epigastric pain with vomiting. Previous gallbladder drainage for acute empyema of gallbladder. This attack progressive.

Operation revealed huge gallbladder, completely filled with disintegrated stones, mucosa necrotic, stone impacted in cystic duct, with numerous adhesions.

Case 10.—A. F., aged 36. Several acute attacks of gallstone colic within the last few years. Treated for indigestion. Final attack persistent.

Operation revealed many adhesions covering the gallbladder completely, filled with

FIG. 3 (Case 15).—Many gallstones, impacted cystic duct. Fundus gangrenous, not ruptured.



FIG. 4 (Case 16).—Huge impacted cystic stone. Empty. Abscess. Gangrenous per-



stones, one mulberry stone impacted in cystic duct with perforation leading to post-duodenal abscess.

Case 11.—Mrs. N. A., aged 38. Long standing indigestion with intermittent pain in right upper quadrant, accompanied by slight icterus. Present attack subacute but progressive.

Operation revealed hour-glass constriction about middle portion of gallbladder with the cystic portion filled with impacted stones. Common duct compressed and edematous from impacted stone in cystic duct. Multiple adhesions.

Case 12.—Mrs. H. O., aged 31. Several years' history of acute and chronic indigestion. Final attack progressive with jaundice.

Operation revealed a huge infected hydrops of gallbladder with impacted cystic duct stone and ball valve common duct stone, proximal to cystic duct.

Case 13.—Mrs. M. B., aged 86. Persistent jaundice, with severe itching of skin. Pain in upper right quadrant, continuous nausea and vomiting. Demanded relief.

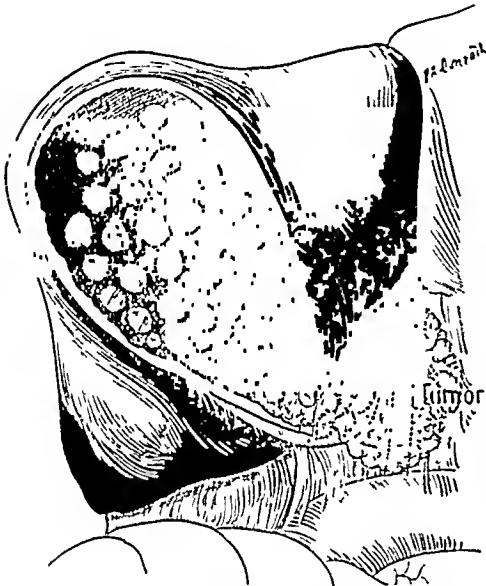


FIG. 5 (Case 18).—Large gallbladder filled with stones. Gangrenous mucosa. Tumor (a) involving cystic and common duct.

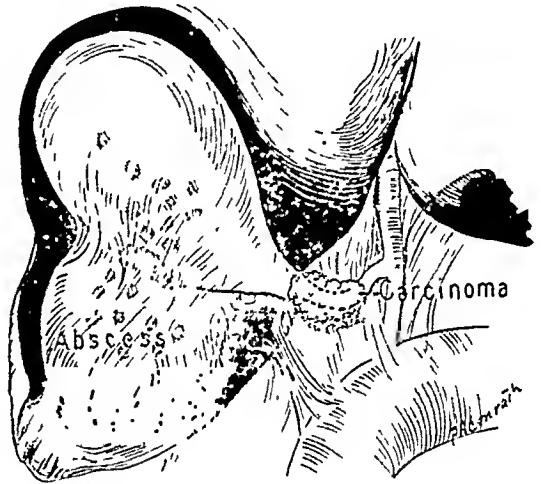


FIG. 6 (Case 19).—Gallbladder ruptured. Abscess containing stones. Carcinoma of cystic duct area.

Operation showed gallbladder filled with stones, single stones obstructing cystic duct and common duct. Removal of stones with drainage of cystic duct and common duct. Symptoms relieved, lived comfortably six years.

Case 14.—Mrs. L. W. M., aged 47. Previous attack of appendicitis; recurrent attacks of epigastric pain for over five years following appendicitis operation. Slight icterus. Final attack acute and progressive.

Operation revealed a large adherent gallbladder filled with stones, with cystic duct obstructed and tip of gallbladder fundus gangrenous, threatening perforation. Two-stage removal.

Case 15.—Mrs. M. V., aged 28. Several years complained of indigestion and biliary colic. Present attack continuous and progressive with symptoms of infection.

Operation revealed greatly enlarged gallbladder, gangrenous at the presenting fundus, filled with large stones, with cystic duct completely obstructed by impacted stone. Numerous pericystic adhesions.

Case 16.—Mrs. Wm. C., aged 36. Gastro-intestinal symptoms for 20 years; fre-

COMPLICATIONS OF CHOLELITHIASIS

quent attacks of gallbladder colic with transient jaundice. Cholecystostomy 12 years ago. Abdominal exploratory eight and one-half years ago. Present attack progressively acute.

Operation revealed large oval impacted cystic stone with perforation near fundus and abscess lying between gallbladder and transverse colon. Gangrenous at site of perforation.

Case 17.—Mrs. E. H., aged 55. Epigastric pain and indigestion for over 20 years. Developed cardiorenal complex with hypertension. Final attack progressive and acute.

Operation revealed an acute gangrenous, edematous gallbladder, filled with stones, surrounded by mucopurulent abscess walled off by omentum. Drainage under local anesthesia. Cardiorenal death on third postoperative day.

Case 18.—McD., aged 64. For over 20 years, severe attacks of indigestion with almost persistent tenderness over right hypochondrium. Final attack progressive with persistent jaundice.



FIG. 7 (Case 23).—Four distinct abscesses, containing purulent bile. Contracted gallbladder. Many adhesions.

Operation revealed a large gallbladder filled with stones, entire mucosa gangrenous. Tumor (Ca.) involving cystic and common duct area. Drainage only. Fatal issue six months later.

Case 19.—Mrs. B. M., aged 35. Intermittent attacks of gallbladder pain with indigestion, flatulence, abdominal distension, *etc.* Final attack continuous and progressive.

Operation revealed gallbladder filled with stones, with an adjoining abscess containing gallstones; numerous protective adhesions. Condition permitted gallbladder and abscess drainage with a removal of stones only. Subsequent operation refused until recurrent attack one year later. Operation revealed empyema of gallbladder with malignant tumor involving cystic duct area, pancreas considerably enlarged, multiple adhesions. Died one and one-half years later.

Case 20.—C. W., aged 69. Irregular attacks of epigastric pain for 35 years, jaundiced over six months, 28 pounds weight loss. Last attack progressive.

Operation revealed multiple gastrohepatic and colohepatic adhesions, completely



FIG. 9 (Case 25).—Gallbladder and cystic duct filled with stones—impacted. One large stone perforated into abscess.

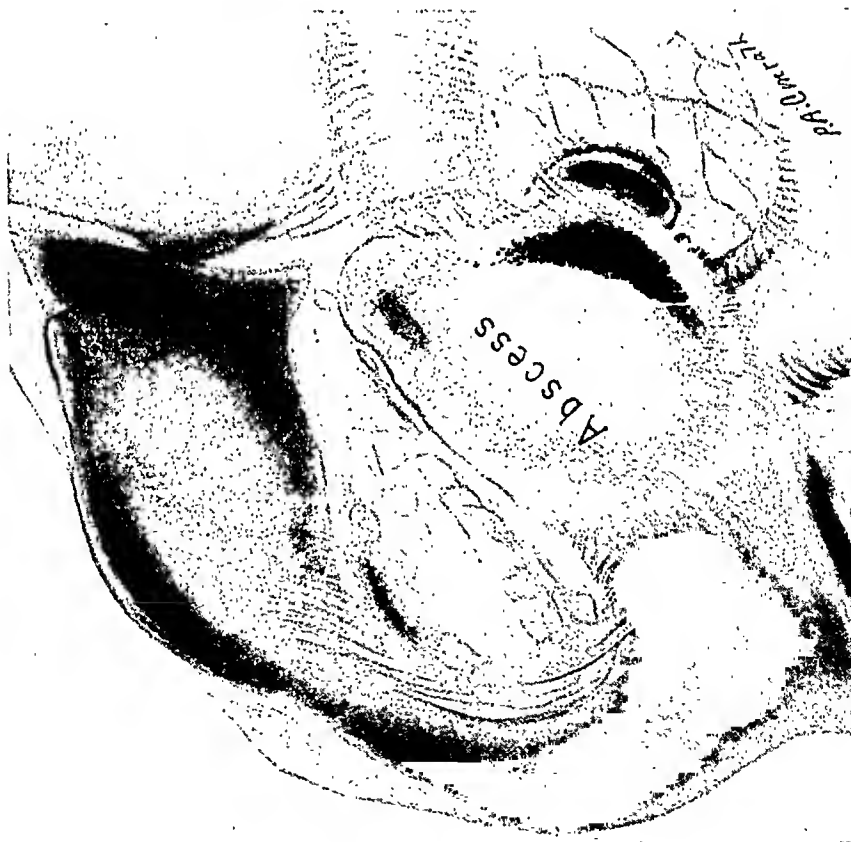


FIG. 8 (Case 24).—Gallbladder filled with stones. Perforation with abscess overlying head of pancreas.

COMPLICATIONS OF CHOLELITHIASIS

burying small gallbladder which contained granular stones and one impacted cystic stone with perforation and pericystic abscess.

Case 21.—Miss L. O., aged 50. Seven years' upper abdominal discomfort, flatulence and frequent attacks of pain with icterus, lasting one to two months. Persistent jaundice during final attack.

Operation revealed small abscess, covered by duodenal adhesions. Gallbladder filled with stones, cystic duct presenting an impacted stone of large size which had perforated, forming abscess. Multiple adhesions.

Case 22.—Mrs. J. R., aged 52. Recurrent attacks of pain in epigastrium, bloating and belching, with nausea for more than ten years. Final attack severe.

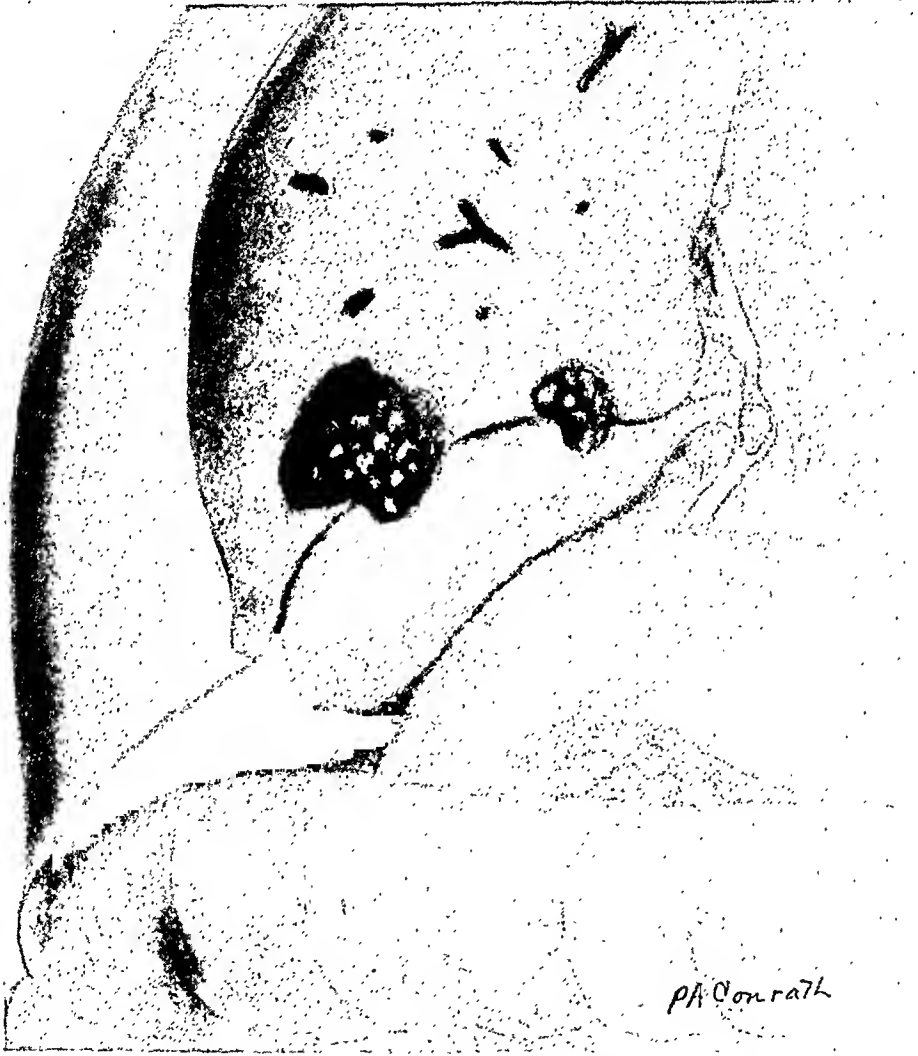


FIG. 10 (Case 28).—Double perforation into liver bed, both abscesses containing stones. Common duct stone impacted.

Operation revealed an old healed perforation near the cystic end of the gallbladder, opposite impacted cystic stone. Entire area between gallbladder and duodenum filled with a granuloma, evidently the result of a preexisting abscess following perforation.

Case 23.—J. W. McL., aged 55. History of infected right kidney, not perinephritic; for several years had mild attacks of indigestion. Six months previous, hospitalized for acute right kidney infection, developed severe pain in lower dorsal spine requiring cast. While in hospital developed symptoms of acute obstructive cholecystitis with perforation and drainage into stomach or duodenum. Rapid recovery for four months; again stricken with severe epigastric pain, temperature and classic symptoms of gallbladder infection.

Operation revealed small contracted gallbladder buried in adhesions. No stones palpable in gallbladder or common duct, duodenum overlying and adherent; there were four distinct abscess cavities, segregated and lying between transverse colon, omentum and liver.

Case 24.—Mrs. F. C., aged 50. Indigestion and nausea with intermittent attacks of epigastric pain for many years. Final attack progressive.

Operation revealed gallbladder completely filled with stones, resting upon a huge abscess overlying duodenum and head of pancreas. Gallbladder perforation had healed.

Case 25.—Mrs. L. S., aged 62. Indigestion for 20 years. Frequent acute attacks of pain with transient jaundice. Final attack progressive.

Operation revealed gallbladder and cystic duct filled with stones, one large stone impacted in perforation with surrounding abscess.

Case 26.—Mrs. E. B., aged 57. Acute painful gallbladder attacks of several years, final attack continuous.

Operation revealed perforation of gallbladder through its bed, into the liver, with abscess formation containing stones.

Case 27.—E. N., aged 51. Intermittent attacks of gallbladder colic for 30 years; several attacks of icterus. Final attack progressive.

Operation revealed acutely infected gallbladder, filled with stones, completely buried in colohaptic fibrous adhesions. One large gallstone had perforated into liver bed near the fundus, surrounded by abscess.

Case 28.—Mrs. J. B., aged 65. Over 20 years of upper abdominal discomfort, treated 15 years for indigestion. Rapid loss of weight preceding final progressive attack. Deeply jaundiced.

Operation revealed large thick walled gallbladder with numerous adhesions from transverse colon and gastrohepatic omentum. Gallbladder filled with stones, two distinct perforations through gallbladder bed into liver substance, with abscess, both cavities containing stones. Single stone impacted at junction of cystic and common duct.

All of the 200 cases reviewed gave positive evidence of varying periods of disabling symptoms; all of them ascribed their early disability to various forms of "dyspepsia," "indigestion," "nervous indigestion" and dietary indiscretions; most of them had been under a physician's care for a prolonged period; the majority had suffered actual biliary colic many times with transient or persistent jaundice, intestinal dysfunction and fading health; among those who were diagnosed, frequent duodenal drainage and bile salts were the prescribed treatment. Several resorted to the assuring care of the stone-dissolving charlatan, the osteopath, chiropractor or to Christian Science. The morbidity of a disease should lessen in proportion to increasing knowledge of the cause and effect and by virtue of improvement in diagnosis and therapeutic control. Such is anticipated in medical progress. This is apparently not true of gall tract disease in general. Our broader knowledge of the physiologic function of the liver and of its susceptibility to disease, our ability to detect pathology early and a constantly improving technic, should arm us with a more effective remedy and yet our end-result in treating hepatic disorder is not comparable to that of any other disease of which infection is the basic cause.

The early concept of the physician's duty was the treatment of disease. We have long known that it is far more commendable and economically advantageous to prevent accident, illness or life-threatening operations when

COMPLICATIONS OF CHOLELITHIASIS

TABLE II

RÉSUMÉ OF THE TWENTY-EIGHT REPORTED CASES

No.	Age	Years of Indigestion Symptoms	Years of Painful Attacks	Complications	Jaundice	Final Attack
1	60	30	5	Psychoneurotic	None	Interval
2	48	20	20	Cardiorenal	Slight	Prog.
3	51	30	27	Narcotics	W. attk.	Interval
4	30	5	3	Panc. tumor	Slight	Ac. prog.
5	55	20	5		None	Interval
6	32	8	8	App. 9 yrs.	None	Interval
7	30	5	2	Gangrene	Fin. attk.	Ae. prog.
8	55	25	25		Slight	Ac. prog.
9	51	20	7	Perst. vom.	None	Ac. prog.
10	36	10	4		None	Prog.
11	38	12	5	Hour-glass	Slight	Subacute
12	31	10	5		Recurr.	Prog.
13	86	60	15		Persist.	Prog.
14	47	20	5	App. op.	Slight	Ae. prog.
15	28	8	5	Gang. G. B.	None	Ac. prog.
16	36	20	15	G. B. Dr. 12 yrs.	None	Ac. prog.
17	55	20	10	Cardiorenal	None	Ac. prog.
18	64	30	20	Ca. cystic D.	Persist.	Ac. prog.
19	35	10	3	Ca. eystic D.	Slow prog.	Ac. prog.
20	69	35	35	Wt. loss	W. attk.	Ac. prog.
21	50	20	6	Flatulence	Persist.	Ac. prog.
22	52	10	10	Healed perf.	Slight	Ac. prog.
23	55	15	7	G. B. perf. duod.	One attk.	Interval
24	50	20	20	Hcaled perf.	W. attk.	Ac. prog.
25	62	25	20		Transient	Ae. prog.
26	57	20	10	Seientist	W. attk.	Chr. inf.
27	51	30	30	Psyehosis	Sev. attk.	Ac. prog.
28	65	25	20	Wt. loss	W. attk.	Ac. prog.
Average	50	20	12		20 Pos.	5 Int. 23 Ac. prog.

possible. Had we the foresight to expend but a fraction of the time and energy which is applied to eradicating or controlling an active pathology, upon the problem of anticipating the disease, perfecting early diagnosis and applying preventive medicine and surgery during its inception, we could well boast actual progress and more firmly establish our value as custodians of the public health.

It has well been said that the palm of one hand properly placed in the upper right quadrant will cover the source of the major portion of serious abdominal pathology. This indictment may appear unwarranted until we recall that the seemingly innocent presence of gallstones may later account for (a) indigestion mild or severe, but persistent; (b) obstruction of cystic or common duct, with disastrous sequelae, such as hydrops, empyema, gangrene, perforation and abscess; (c) recurrent infections transmitted to the

liver, increasing dysfunction; (d) pain from insignificant soreness to intense colic; (e) jaundice, mild or severe, persistent or recurrent; (f) cholangitis, pancreatitis, hemorrhagic or cystic and cancer (from 50 per cent to 75 per cent of all cancers of the gall tract and pancreas show the presence of gallstones).

Is gallbladder disease with gallstones a medical problem? Is cholelithiasis ever actually relieved by the spontaneous passing of all resident stones through the natural channels? Is a definitely diseased gallbladder with gallstones ever "cured" spontaneously or by duodenal drainage or other medical therapeutic agents? Assuming a negative answer to these pertinent questions, should we without protest permit this definitely surgical disease to pass from the stage of a safe operative risk, on to the certain development of disastrous sequelae, without fully informing the patient of its potentialities? My experience impels me to classify the infected gallbladder with stones in the same category as the pathologic appendix, the toxic goiter and progressive obstruction as definite surgical problems entitled to prompt surgical attention when diagnosis is certain and before irremedial liver, gall tract and pancreatic damage has been inflicted.

Medical scientists the world over are continually striving to alleviate pain, lessen morbidity and reduce mortality. Whether this be attained by prevention of disease and injury, medical therapy or surgery, preservation of life and health is the objective. Therapeutic discoveries of great value are infrequent. The extension of life and health by surgical effort is largely dependent upon time, technic and surgical judgment. Educational aid, by informing the public of the early symptoms of serious illness and persuading them to accept prompt medical care, is the most pertinent single factor in mortality reduction. Such an effort will miscarry if the family physician fails to adopt a preventive attitude and to cooperate accordingly. A startling reduction in our present mortality rate is possible and feasible, whenever the tremendous value of preventive surgery is recognized and both physician and patient become preventive conscious. Preventive medicine has long been accepted as a most valuable adjunct. Preventive surgery is as yet an embryo and has in no wise kept pace with preventive medicine. A life ultimately saved by a few words of advice or by a safe, early operation is just as valuable as one preserved after a thrilling fight by heroic surgery and definitely lessens the morbidity.

CONCLUSIONS

(1) From a review of 200 gallbladder operations, more than 50 or 25 per cent were seriously complicated, requiring life endangering operations. Twenty-eight are briefly presented.

(2) Infected gallbladder with stone is usually a progressive pathology, gradually merging from a simple to a serious surgical problem.

(3) Persistent symptoms of indigestion, dyspepsia, flatulence or upper abdominal pain justify careful examination and observation. A diseased

gallbladder seldom, if ever, entirely heals, and usually becomes a factory for stones and related complications.

(4) Early or preventive surgery in a frankly surgical disease is a most potent factor for safety, and is quite as essential in gallbladder disease as it is in toxic goiter, appendicitis or chronic intestinal obstruction.

(5) There is urgent need for a closer cooperation of all branches of medical service toward preventive medicine and surgery. Successful prevention will not be realized unless our major and minor medical bodies promote an active educational plan, which will teach the layman to recognize and respect early symptoms of dangerous diseases and to place themselves under competent medical care. Thus will be marshaled an effective enemy of morbidity and mortality.

THE TREATMENT OF AMEBIC ABSCESS OF THE LIVER

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OUR sole purpose in reporting a single case of amebic abscess of the liver is to emphasize the value of its treatment by repeated aspirations in connection with the simultaneous injection of emetine, both intramuscularly and locally, into the abscess cavity. We are not concerned here with the pathogenesis, symptomatology, or diagnosis of amebiasis. Its phenomena have been fully described by clinicians and pathologists in regions where the affection is most prevalent. Its rarity in our immediate geographic area is well known.

CASE REPORT

W. S. H., a farmer, aged 52, was admitted to the Rex Hospital, September 6, 1934, complaining of intense pain in his "right short ribs and back." He dated his illness from two months before admission when he noticed great weakness and drowsiness, but continued to work; three weeks later he "swelled up on his right side," took saline purges for a week, and then went to bed. On September 1, 1934, five days before admission, he had a chill, followed by five others in the course of two days. Since then the pains have persisted, radiating to each side of the chest and back. Further questioning elicited the fact that since 1932 he had had, at intervals, blood in his stools, associated with diarrhea and occasional hematemesis.

Physical examination showed a tall, emaciated man, with drawn, pinched features, sunken eyes and leaking skin. His face expressed anxiety and severe suffering. The chest expansion was poor, but equal on each side, a friction rub was heard over the right sixth interspace anteriorly. There was tenseness on palpation over the right lower chest and upper abdominal quadrant. The liver was enlarged upward to the third rib and downward for three inches below the costal margin. An indistinct sense of "pointing" could be elicited at the eighth interspace laterally. The temperature was 103° F.; pulse, 92; respiration, 22 (Chart I); the blood count showed a leukocytosis of 18,000. The next day the protozoa of *Endameba histolytica* were found in the stools. A diagnosis of amebic abscess of the liver seemed evident. Accordingly, an intramuscular injection of a grain of emetine hydrochloride was immediately given, and orders were left for this to be continued daily. Roentgenologic examination showed the diaphragm pushed evenly upward and it appeared to be under pressure from beneath. The liver enlargement and its increased density were observed (Fig. 1). Meanwhile the patient's condition did not improve; the elevated temperature remained, the pain was increasing, the liver was enlarging and the pulse was becoming more rapid. On the third day, a needle was introduced into the liver through the eighth interspace in the midaxillary line and four ounces of thick, odorless pus were evacuated (Fig. 2). Before removing the needle two grains of emetine were injected through it into the abscess cavity. Encysted forms of the *Endameba* were found in the pus.

The temperature dropped promptly, reaching normal within two days (Chart I) and never reached its original height; the pain was lessened and the patient's general condition

FIG. 1.—Roentgenogram on admission, showing liver enlargement.



FIG. 2.—Roentgenogram after first aspiration. Less density of liver shadow.



FIG. 3.—Roentgenogram after sixth aspiration.



improved. Five days later the liver increased in size, especially upward and to the left, and a pericardial friction rub was noticed. A second aspiration of the liver in the same area as before was made two days later, but no pus was located. After another five days the liver was again aspirated at the original site and ten ounces of pus removed, of a light brownish color, and not nearly so thick as that previously evacuated, was aspirated. The pericardial friction sound continued and after five more days the patient became slightly cyanotic. At a fourth aspiration of the liver ten ounces of thin chocolate colored fluid were obtained, after which the patient was much more comfortable. The liver was markedly reduced in size.

Nine days later, on October 6, just a month after admission, pain in the right chest appeared and the temperature rose to 101° F. The roentgenologic report was: "Liver shadow not so dense but the right chest is cloudy, suggestive of pleurisy with effusion." Paracentesis of the chest yielded four ounces of yellowish gelatinous fluid. Immediate relief of pain and a drop in temperature followed (Chart II). Three other aspirations of the liver were performed (Fig. 3), making seven altogether, one yielding eight ounces, one ten ounces, and the last none. During the period of the liver aspirations there appeared to be one large abscess, with possibly three or four smaller ones apparently coalescing with the main cavity as the treatment continued. Each time the needle was inserted in the eighth interspace, changing its direction somewhat after entrance, and two grains of emetine were introduced into the liver after each aspiration. One additional puncture of the right chest obtained no fluid. The patient was discharged October 28, 1934. He has remained well, and has had no return of symptoms to the present time.

Critique.—Two questionable points suggest themselves in the conduct of this case. First, it might be asked why we did not wait longer at the beginning to secure the systemic action of emetine before evacuating the abscess. It is agreed that the routine administration of emetine, one grain daily for ten days, should precede any operative procedure, provided the patient is seen early and there is time to wait for possible improvement. Undoubtedly the use of emetine (or some other drug of similar action) may prevent or abort the formation of an abscess in the liver at the very beginning. In the present case, however, the urgency was so great, and the abscess so large, that immediate evacuation was considered advisable, permitting a continuation of the emetine generally and locally.

The second question comes up in connection with the right pleural effusion. Was it present originally, as has occurred in other cases, and was it overshadowed by the liver enlargement? Or was it due to interference with the pleura in the various aspirations of the abscess? We think the pleurisy was a necessary complication in this delayed case, and we were not willing to aspirate the pleural cavity until the liver had receded sufficiently for differentiation. This could not have been brought about rapidly without at least partial evacuation of the liver abscess.

Abstracted Reports of Fellows of the Southern Surgical Association.—The subject of abscess of the liver, notably the amebic type, manifestly is of special interest to the Fellows of the Southern Surgical Association. Its membership embraces largely a region in which the affection is comparatively common and several of our Fellows have presented reports of their experience. This is the first case of the kind seen in our service, although one of us (H.A.R.) has operated upon three liver abscesses of metastatic origin, not

AMEBIC ABSCESS OF THE LIVER

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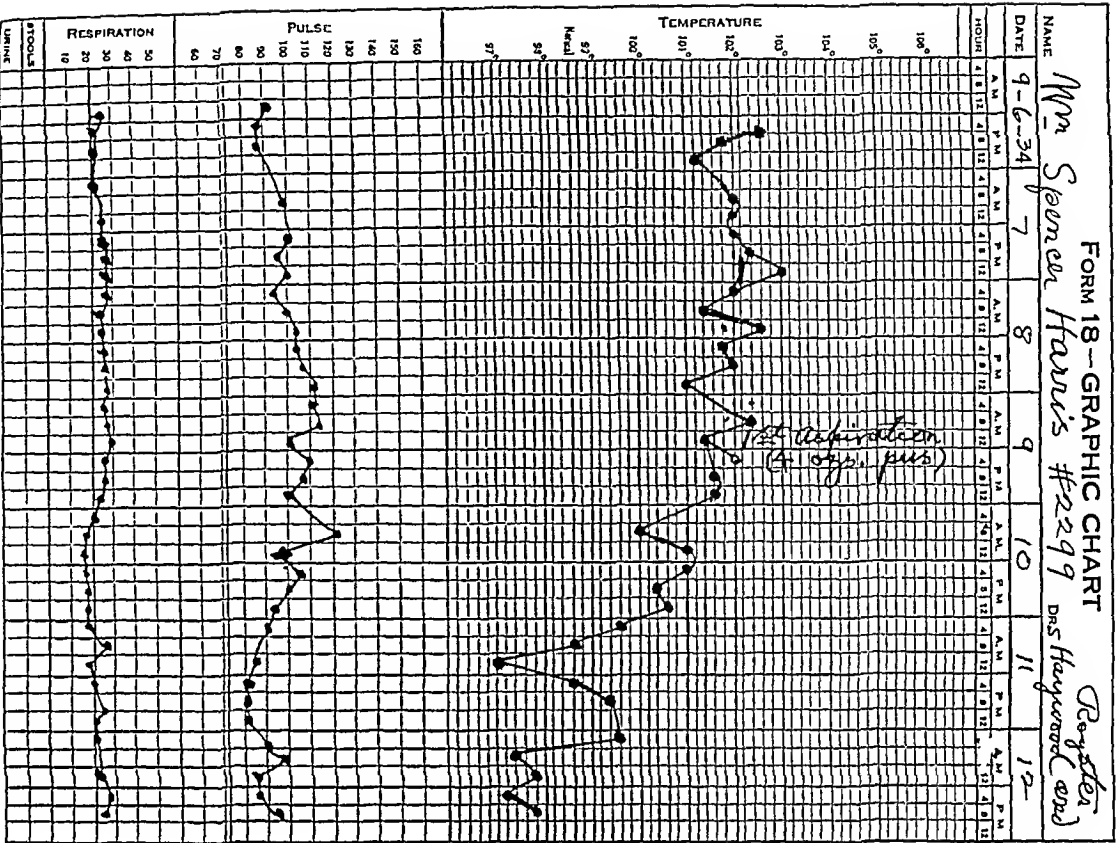


CHART I.—Temperature on admission and after first aspiration.

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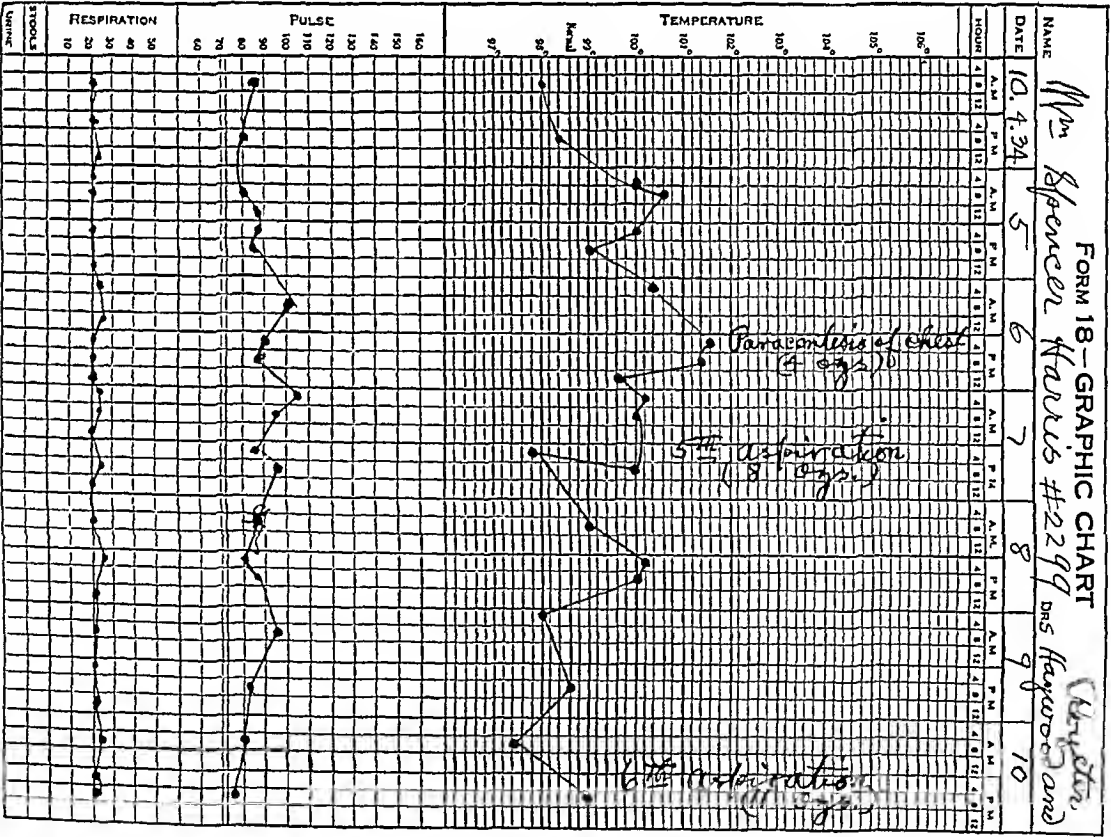


CHART II.—Temperature one month after admission and at time of tapping pleural effusion, and fifth and sixth aspirations of abscess.

caused by the *Endameba*. Parham, in 1922, reported an instance of abscess of the liver¹ in a man aged 42, giving a history of frequent stools with blood and mucus for 21 months, who had been transferred from the medical division, where he had been under observation for eight days. "Amebae were suspected as the cause of the dysentery, but none were found," and "an exploring syringe was used in the eighth intercostal space, obtaining a thick, creamy pus, which showed in smear and on culture, the colon bacillus." The liver was enlarged more upward than downward, there was a high leukocytic count, and a temperature of 102° F. had been present, "though the febrile movement had not been marked." The diagnosis as made was "abscess of the liver, bacterial in origin, probably a sequence of the dystentery." The prognosis was considered unfavorable, as dealing "with a septic abscess rather than with the old classic, single, tropical abscess of Murchison, which we now know to be amebic." A transpleural operation was done, resecting the ninth rib posteriorly, opening the pleura, suturing the diaphragm to the muscular tissue and the liver to the diaphragm, evacuating the liver abscess and packing with iodoform gauze. "The pus at operation showed no organism and remained sterile on culture. It is probable, therefore, that the abscess was, after all, amebic and not a septic multiple abscess. We, therefore, gave him a few doses of emetine." The patient recovered but was still in the hospital at the end of the eighty-eighth day following his admission.

Boland (1931) had a series of 19 cases, 14 of the amebic type, with five deaths all presumably treated by open operation.

In 1933, Gessner contributed a report on 96 cases of true amebic abscess of the liver seen in New Orleans from 1918 to 1932 with a death rate of 39.58 per cent, with no differentiation of methods of management. But he quotes from the paper of Rogers a contrast of the open operation with 56.7 per cent mortality and the aspiration method with 14.4 per cent of deaths. Further, Rogers pointed out that his pupil Chathrji had treated 186 liver abscesses by aspiration with a mortality of 1.6 per cent.

Matas (1933) noted the gradually decreasing mortality of amebic liver abscess in later years and attributes it to earlier diagnosis, better types of patients and to the use of emetine along with repeated aspiration.

Hogan, in 1934, presented before the Southern Surgical Association a thorough review of the pathologic ravages of the *Endameba histolytica*. In reference to amebic abscess of the liver, he concludes, "If the emetine treatment hypodermically and aspiration and irrigation when indicated . . . secure the remarkable results . . . that have been reported, it is a remarkably good method of treatment." In the discussion of Hogan's paper, Noland expressed himself as distinctly opposed to the aspiration treatment of liver abscesses of amebic origin. He considers them frequently multiple, that aspiration of the dome of the liver is liable to infect the pleura, that often the puncture of the liver causes a leak into the abdominal cavity; and he strongly advocates abdominal exploration through a high incision in cases of suspected liver abscess, followed by rib resection, if needed, and open operation with drainage.

At that time Alton Ochsner called attention to the drop in the mortality rate from 47.2 per cent under open drainage methods to 6.9 per cent under conservative treatment. Later (1935) Ochsner and DeBakey published an exhaustive compilation of the literature of liver abscess, including a study of 73 cases of their own. Their "lowest mortality rate (4.1 per cent) was obtained in 24 cases treated conservatively by aspiration and the use of amebicides," and they concluded that "open operation should be employed only in those cases in which there is infection with pyogenic microorganisms."

Other Recent Reports.—In June, 1934, Brown, of the Mayo Clinic, reported 22 cases of damage to the liver from amebiasis, in 16 of which there was abscess formation, and in six others evidence of hepatic involvement—chills, fever, leukocytosis and tenderness in the region of the liver. One of the abscess cases, virtually moribund, died soon after admission, following open drainage. Autopsy revealed that the abscess had ruptured into the peritoneal cavity. "In the remaining 15 cases of known abscess, aspiration or open drainage had been done, accompanied by anti-amebic treatment. So far as we know all these patients have been cured."

Pauline Williams, in reporting an autopsy of a fatal case of amebic hepatic abscess, without previous dysentery or diarrhea, quotes Harrington as observing "a case of known amebic dysentery in which liver abscess developed even though the patient was given extensive treatment with emetine."

About two months ago (October, 1935) Holmes, of Chicago, published a paper on the medical treatment of amebic infections of the liver, reporting two cases of liver abscess, both treated with emetine alone, without either aspiration or open operation. Both patients recovered. In the first case a pleural effusion was suspected, but thoracentesis gave negative results. Under emetine therapy, the patient recovered rapidly and was discharged at the end of 12 days. The second patient received the same treatment, but seems to have had a much slower recovery. Holmes voices strong objections to any surgical interference in amebic abscess of the liver, saying that both aspiration and open operation "should be reserved for cases complicated by secondary bacterial infections and for other complications, such as rupture of the abscess into the pleural or peritoneal cavities." He cites the following disadvantages of the aspiration method: that the abscess cannot be evacuated completely and the needle may cause dissemination throughout the liver, that no account is taken of multiple abscesses, which he thinks are not uncommon, that the parasite is not disturbed even by complete evacuation, since the amebae exist "at varying depths in solid liver tissue" and finally that "surgical treatment of an uncomplicated amebic abscess is illogical."

Comment.—Referring first to the conclusions expressed by Holmes, some of which are sound, we believe it proper to inquire how an abscess of the liver can be diagnosed with certainty unless the pus be demonstrated either by needle or knife. It must be remembered that acute hepatitis is the early manifestation of the liver invasion and that its symptoms are similar to, and often just as pronounced as, those which are observed when abscess super-

venes. As stated by Holmes, "the symptoms of the stage of abscess do not differ materially from those of the stage of hepatitis." It is granted that emetine should be used from the beginning in any suspected case, and that in many instances, abscess may be prevented or even aborted when it is seen in an early stage and is of insignificant size. But it would be unfair, we think, to assume the presence of a large abscess without actually seeing the pus, just as it would be improper to omit the routine use of emetine along with evacuation of the pus. Surely for diagnostic purposes, if not for therapeutic reasons, aspiration has a place, chiefly in the neglected cases, and especially in those of an emergency nature, requiring immediate relief from pressure symptoms in patients too ill to undergo an open operation and too far advanced to wait for the effects of an anebicide. Here may be reemphasized the injection of two grains of emetine through the aspirating needle after each withdrawal of pus, thus attacking the amebae in the depths of the liver tissues.

The criticism of Noland concerning infection of the pleura in aspiration of the dome of the liver has merit. It is not only possible, but quite probable; and yet this occurrence, in our opinion, is more than offset by the disasters, dangers and disabilities ensuing from the more formidable operation of incision and open drainage. The important answer to this objection is found in the overwhelming reduction of the mortality rate since the employment of the aspiration method. With care, contamination of the pleura apparently does not occur either in the introduction and withdrawal of the aspirating needle, or in the conduct of the open operation, the only difference being in the more serious character of the latter, with its exposure to outside infection and a longer period of confinement. Undoubtedly in many cases pleural effusion is present before any treatment is undertaken, as it has been shown that amebae may invade and penetrate the diaphragm from an abscess in the dome of the liver. It would appear that the effects of involvement of the pleura, which occasionally happens during aspiration of the liver abscess, have been exaggerated.

Summary.—In summarizing our own conclusions on the subject, we can do no better than to quote from Carson's *Operative Surgery* (1924) a paragraph written by G. Grey Turner: "The whole subject of the treatment of tropical abscess of the liver has been placed on a new footing since the value of emetine has become appreciated in the treatment of amebiasis. Our previous knowledge of liver abscesses was largely derived from cases much further advanced than are likely to be met with today, and the treatment was based on the assumption that the pus of such abscesses was pyogenetic in origin, whereas we now know that in the large majority of cases it is sterile. These abscesses are commonest in the right lobe, but in about 40 per cent of cases they are multiple. There is abundant evidence to show that such abscesses can spontaneously recover, and the aim of the treatment at the present time is to imitate the processes by which nature brings this about. One essential is to saturate the circulating lymph with emetine, which is inimical to the

ameba. In some cases this is all that is required, and the pus becomes innocuous, and either disappears or becomes inspissated. When further aid is necessary, the tension in the abscess must be relieved so as to encourage an outpouring of emetine saturated lymph from its walls and to allow of their collapse or retraction. This is done by the withdrawal of pus. The process may be repeated, but it is not essential that all the pus be removed. The routine treatment ought, therefore, to consist of (a) the intramuscular injection of emetine hydrochloride, 1 gr. daily for 10 days; (b) removal of the pus either with a large exploring syringe or an aspirator. The evacuation of pus may be carried out when the case is first seen, if there are urgent symptoms due to the size or situation of the abscess, but it is better deferred until a course of emetine has been administered. If there is evidence of secondary infection, or the case is not doing well, the operation of open incision may be subsequently required; but the preliminary treatment by emetine is necessary in all cases, and aspiration may further help to render open operation more successful."

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DISCUSSION.—DR. ALTON OCHSNER (New Orleans, La.).—Doctor Royster referred to the group of cases which Doctor DeBakey and I reviewed. The relative proportion of amebic and non-amebic abscesses in the 102 cases considered was 71.5 per cent amebic and 28.4 per cent non-amebic. Amebae were found in 17.4 per cent of amebic abscesses and in 36.1 per cent of the stools of these same cases with amebic abscess. As regards the clinical manifestations, fever was present in 69.8 per cent and enlargement of the liver in 65.7 per cent.

The diagnosis of abscess of the liver is greatly facilitated by roentgenograms. As shown by Granger, a localized bulging into the lung field is usually indicative of hepatic suppuration, although it may rarely be the result of a gumma of the liver. As many cases of amebic abscess are seen after perforation into the subphrenic space has occurred, the roentgenogram is of inestimable value. In such an instance, in the anteroposterior view there is elevation of the medial portion of the right diaphragm with obliteration of the cardiophrenic angle, whereas that taken from the side shows an elevation of the anterior portion of the diaphragm and obliteration of the anterior costophrenic angle. On the other hand, in pyogenic subphrenic infections, which are usually secondary to appendiceal infections, in the anteroposterior roentgenogram there is elevation of the lateral half of the diaphragmatic leaf with obliteration of the costophrenic angle and in the lateral view there is elevation of the posterior portion of the diaphragm with obliteration of the posterior costophrenic angle.

In 16 cases treated by transpleural drainage there was a 25 per cent mortality. In 14 cases treated by a right rectus incision there was a 21.4 per cent mortality. In seven cases treated by incision and drainage over the most prominent presenting portion there was a 14.2 per cent mortality. In nine cases treated by incision through the retroperitoneal approach there was 11.1 per cent mortality, whereas in 24 cases treated by aspiration and emetine there was a 4.1 per cent mortality. The combined mortality in the entire group of 70 cases was 14.2 per cent.

We feel that emetine should be used with extreme caution. It is a dangerous drug, and the total amount given should never exceed 10 grains. Other amebicides should not be used, because they are liver poisons and exert little effect on the amebae in the liver. As most amebic abscesses are sterile (89 per cent of our cases), open drainage is undesirable because of the danger



FIG. 4.—The sectioned surface of the liver, through five of the amebic abscesses. One near the diaphragmatic surface was drained (Dr. Louis Frank).

of secondary infection which markedly increases the mortality rate. Conservative treatment consisting of aspiration and emetine administration is the treatment of choice. We feel that these abscesses are analogous to tuberculous abscesses, and the patient who dies does so as the result of secondary infection.

DR. LOUIS FRANK (Louisville, Ky.).—Not living on the Southern coast but inland we have seen but few cases of amebic abscesses until the recent endemic which had its origin in Chicago. Since that time we have had an opportunity of seeing quite a few. Early in the epidemic there was some confusion in diagnosis and several cases were operated upon as appendicitis and one for supposed malignancy of the cecum, all which ended disastrously. Our own experience with abscess of the liver of amebic origin dates back 30 years. The patient had never been out of the State, and had a single

abscess of considerable size in the right lobe of the liver. He recovered following an open operation.

Among the cases arising from infection in Chicago there were two with liver abscess. One, unfortunately, was multiple from the beginning and presented symptoms of such acute character that we thought immediate operation was demanded. Two abscesses were identified and drained. The patient died 48 hours subsequently. He had been under active treatment with emetine for five days preceding his operation. At autopsy seven abscesses were found in the liver (Fig. 4). It is quite possible that this patient might have done better if the emetine had been continued and had he not been operated upon, but the symptoms were so acute that we believed intervention was demanded. The cecum was studded extensively with amebic ulcers and was much thickened. The ileocecal valve was so markedly involved that it was held patent, as demonstrated by the barium enema.

The other patient we saw with liver abscess was a boy, who possibly had an abscess present at the time of his admission to the hospital. The case was diagnosed as acute appendicitis and the appendix was removed. The temperature continued and he developed other more definite symptoms of liver abscess. His first abscess was in the left lobe of the liver. This was opened and drained. He improved but later developed an abscess in the right lobe which in turn was also drained. This was followed by a massive lung collapse, which under a tent with oxygen and CO₂ gradually cleared up, but was shortly followed by a lung abscess necessitating the resection of a rib. He was in the hospital four months, but finally made a good recovery.

A diagnostic point which we would like to call to your attention, and which we think can usually be elicited, is true and definite finger point tenderness. This we believe is a very important diagnostic finding, and with careful study of the case, and the other symptoms which present, should enable one to make a diagnosis.

We believe, as Doctor Ochsner has just mentioned, that these cases of abscess of the liver occur chiefly in those individuals having a preponderance of the amebic infection located in the right colon and in the cecum. We also believe the cecum will show in such cases, with or without abscess of the liver, some very typical findings. Usually there is a shortening of the cecum, apparently the result of the infiltration and an ileocecal incompetency. This condition may easily be mistaken for a new growth or even for a tuberculous process.

DR. HUBERT A. ROYSTER (closing).—I believe with Doctor Ochsner that as a rule one aspiration in a case is sufficient if seen early. The repeated aspirations in our case were carried out because of the continued pain and swelling in spite of the drop in temperature. The needle was inserted in different places. We had the feeling that there were abscesses in various places, all in the right lobe. The fact that we had a pericardial friction sound might lead one to think that there might have been abscesses in the left lobe also, but continued emetine therapy, we felt, would take care of them. We know that 40 per cent of these abscesses are multiple, but there is no way of finding that out in the beginning, and it seems to us the repeated aspirations for relief are safe. After each aspiration we also injected two grains of emetine into the abscess cavity through the needle. I believe this is important, for if there is any value in emetine we obtain it both through the circulation and in the abscess cavity. Of course, the regenerative powers of the liver are well known. I think if I had a similar case, in which we felt that multiple abscesses were actually present, we would use the same treatment.

ABDOMINAL GAS BACILLUS CATASTROPHES

ROBERT L. RHODES, M.D.

AUGUSTA, GA.

GAS bacillus infection in several of its aspects has been presented before this association during the past several years, *i.e.*, in compound fractures and postoperative drainage wounds, which have been associated with injuries or perforative or suppurative abdominal lesions. It is my purpose to offer for discussion, founded upon two cases, gas bacillus infection of the intestinal tract and peritoneum in which there was no evidence of perforation or suppuration. Whether or not they should be classed as gas gangrene of the gastro-intestinal canal (small bowel) or gaseous peritonitis, remains for your decision. This title was selected as a statement of facts, rather than employing either of the above captions, both of which are, at least, controversial. In all the literature, there has been no attempt to separate those cases not associated with perforative or suppurative processes within the abdomen from those associated with such processes, therefore it has been necessary to review the subject in its entirety.

CASE REPORTS

Case 1.—A colored male, aged 35, night watchman, had had a right inguinal hernia for several years. At 4 A.M. while going down some steps his hernia slipped down, which was nothing unusual, therefore he continued his duties until 7 A.M. when he checked out. Failing in his attempts at reduction he went to a doctor, who was also unsuccessful after a few minutes of taxis and he was sent to the hospital. He arrived at 10 A.M., having vomited several times on the trip, a distance of 65 miles, no vomiting before. Physical examination showed a very muscular man, with a large mass of strangulated hernia, right indirect inguinal, its size suggesting two or three feet of incarcerated bowel. Temperature, 97.8° F.; pulse, 64; white blood count, 10,000; polymorphonuclears, 80 per cent; hemoglobin, 80 per cent; urine negative except for diacetic acid one plus. Preparation for immediate operation was made, sodium amytal Gr. 6, morphine Gr. 1/4 and atropine Gr. 1/150 administered.

Operation.—Under ether anesthesia an incision was made over the inguinal canal. As the peritoneum was opened above the neck of the sac there was a gush of chocolate or coffee colored fluid with an exceedingly foul odor, a pint or more escaping. This odor impressed the entire operating team with its foulness but attracted no more attention at this time. The neck of the sac was incised and about three feet of strangulated bowel withdrawn, several ounces more of the same type fluid escaping. No gas was recognized in the fluid. The strangulated bowel was quite dark; it was carefully examined for any evidence of perforation, but none was found. The viability of the bowel was questionable, but after ten minutes of applications of hot saline packs its color improved markedly and the mesenteric vessels showed no evidence of thrombosis, therefore, it was felt safe to replace it and close the hernia. Four hundred cc. of 10 per cent glucose were given intravenously on the operating table, because of the history of vomiting and the presence of diacetic acid in his urine. He stood the operation well, left the table in excellent condition and reacted normally from the anesthetic. During the afternoon glucose was repeated, as a safety precaution rather than because of any definite indication for it.

At 4 P.M. he expressed himself as feeling so well he was ready to go home. The temperature was 100° F., pulse 130, for which no cause was found. At 7 P.M. the nurse gave him nourishment and was leaving the room when she heard a groan and on looking back saw him throw up his arms, groan again, turn partially over and die at 7.10 P.M. Such a death would have ordinarily been thought to have been due to a pulmonary embolus.

Autopsy by Dr. Edgar R. Pund, 18 hours postmortem: The abdomen was considerably distended, the peritoneal cavity contained much foul smelling gas and some 1,000 cc. of bloody fluid, the serous surfaces were dull and greenish and there was an occasional shred of fibrin. There was gas in the liver, retroperitoneal fat and blood vessels. The small intestine was considerably distended with gas, necrobiotic changes throughout, much more marked in the loops which had been strangulated in the hernia. All tissues and organs were dull and cloudy, sometimes discolored greenish and much gas bubbled from the vessels. The anatomic diagnosis was necrobiosis of intestines, peritonitis, gas bacillus infection.

Case 2.—White male, aged 55. Past history, irrelevant other than that he had always been a heavy meat eater. During the past three years he had had frequent attacks suggesting angiospasm of the right leg, with cramps in the calf which after a short rest would relax. He had had several attacks during the few weeks preceding his present illness, one involving the right hand from which he had not fully recovered and had had no palpable radial pulse since. His present illness was of acute onset and followed a day during which he had felt unusually well. It began at 9.30 P.M. with a sudden pain in the epigastrium, for which he took soda but without relief, the pains soon becoming generalized over the entire abdomen. There had been no dietary indiscretion during the day and his bowels had moved freely three times. The pains became steadily worse during the night; he employed three enemata but only the water returned and without relief of the pain. He was unable to lie down but had to sit in a chair and lean forward, could not lean back. He was in a drenching perspiration all night. About 2 A.M. he began to complain of abdominal distention, took several glasses of hot salt water at half hour intervals, which was regurgitated. He eructated gas in large quantities constantly throughout the night, especially after his abdomen began to swell, but it afforded no relief. Temperature, 96° F. at 6 A.M. Several doses of codeine were taken without any relief; these were retained, as he vomited only after taking the salt water. A cup of hot coffee at 7.30 A.M. was promptly vomited. His distention increased steadily after 2 A.M. and caused more and more difficulty in breathing. At 8 A.M. he went out on the porch to get in the fresh air because of his difficulty in breathing and feeling of suffocation. During the night he had been waxy pale but after daylight a purplish, livid color became progressively more evident. I saw him at 8.30 A.M., sitting in a chair on the porch, cyanotic, gasping for breath, eructating gas in enormous quantities constantly, his abdomen was fearfully distended, tympanitic everywhere, liver dullness obliterated, generalized tenderness and rigidity, a trifle more marked over the right lower quadrant. Temperature, 100° F., pulse, 130. On suggesting an operation, he said, "Well, let's hurry because if you don't soon put a hole in there I'll bust open." His condition became rapidly worse and his color more livid. Temperature, 99.2° F.; pulse, 114; white blood count, 31,800; polymorphonuclears, 89 per cent; urine showed four plus sugar. Blood sugar, 200; N.P.N., 22.4; Wassermann and Kahn tests were later reported as negative. His distention became even more marked, color more cyanotic, and his heart quite embarrassed by the distention. Acute hemorrhagic pancreatitis, in all its violence, seemed the most probable diagnosis.

Operation.—Upon opening his abdomen there was an escape of several ounces of coffee colored fluid with a very foul odor but no gas was recognized. There was no evidence of fat necrosis to suggest pancreatitis. The entire small intestine was distended almost to the point of rupture, the musculature presented striae similar in appearance

to striae albicantes of the skin, several loops were hemorrhagic, and gave very much the appearance of a loop freed from a strangulated hernia. The colon was not distended. It was apparent we were dealing with a gas bacillus infection. Search did not show any evidence of perforation anywhere or acute inflammatory process in appendix or in any other organ. Blood cultures were made which later showed no growth.

Autopsy.—Two hours postmortem: On opening the abdomen the characteristic gas bacillus odor was remarked. Coffee colored fluid, as previously described, and in addition some gas were evacuated. Cultures were made which showed the *Clostridium aerogenes-capsulatus* (Welch). Smears also showed this *Clostridium* and only a very occasional cell. A closer, more detailed search failed to show any point of perforation in the gastro-intestinal tract or evidence of any inflammatory process in appendix, pancreas, liver, gallbladder or elsewhere than in the small intestine where these mottled, congested, hemorrhagic edematous loops were found, the intestine when opened showed no evidence of ulceration anywhere, bubbles of gas were seen in the walls of these loops.

Probably the most exhaustive review of the subject in all its phases is that by W. Lohr,¹ in 1929, which I shall abstract freely. The relationship in perforative lesions of the digestive tract is well established, but this is not true as regards the action of anaerobes as a source of peritoneal infection or the course of anaerobic peritonitis. "Gas Peritonitis" refers to a very peculiar, typical, and apparently rare, disease picture usually following laparotomy. Lohr's description of the course is quite similar to that of Case 2, except he states the intestines are compressed and collapsed by the gas in the abdomen. Gross inflammatory changes in the peritoneum and the intestines are lacking. He refers to one case arising spontaneously in which at operation, the peritoneal cavity was found filled with gas, the intestines normal, the appendix was removed, which histologically showed acute appendicitis and no other pathology found. The patient recovered. (Probably Mischejda's² in which the gas was odorless and had nothing in common with anaerobic gas bacilli.) In all cases reviewed by him bacteriologic examination had not been made. He recognizes that bacteria other than anaerobes can cause gas. In reliable pure culture anaerobic infection of the peritoneum of man and animals the peritonitis began with an exudate poor in cellular constituents and pronounced intestinal paresis and not with excessive accumulation of gas. A gas edema or a gas phlegmon of the stomach and intestine, corresponding to the progredient process of a muscular gas edema, has never occurred. Much larger doses of anaerobes are required to produce a peritoneal infection than a muscular infection and the peritonitis was always without gas formation. His explanation is that gas occurs only when the anaerobic bacilli can produce necrosis in the tissue infected and then produce gaseous decomposition. The fine distribution of the toxin in the peritoneum and the excellent blood supply allows the formation of a toxin to occur which can lead to a dangerous toxic effect, which can be expressed only in capillary paralysis with large exudation of a pale to a very hemorrhagic exudate with but few if any leukocytes. Thus one must assume that gas edema bacilli are not causes of inflammation but only form toxin. The nutri-

tion of the intestines in man and the experimental animal is so secure that there is neither necrosis nor gaseous disintegration of these organs during life.

Again in 1933 Lohr,³ criticising the report of a case of "Gas Gangrene of the Gall Bladder" (Koch⁴), states that in gas gangrene of the liver (gall-bladder), anaerobic peritonitis and gas gangrene of the intestines do not exist, as he could show by numerous references to the literature as well as in his own animal experiments, which has also been proven beyond doubt by Lampa and Galavotti's bacteriologic experimental work.

On the other hand, W. Plath,⁵ in 1934, collected ten cases of gaseous peritonitis in the literature and classified them in three groups. (1) Following operative procedures within or outside the peritoneal cavity, apparently there are no inflammatory signs in the peritoneum. (2) Spontaneous, when apparently an inflammatory factor is present. (3) From the gastro-intestinal tract through a perforation or intact walls. He reports a case in the third group, but since a mass was palpable in the upper abdomen, after a fistula was established, the gas was probably secondary to perforation. An autopsy was not permitted.

Lamprecht,⁶ in 1928, states that primary gas gangrene of the gastro-intestinal canal is very rare but does occur, and refers to five cases described in the literature. (C. Fraenkel, Hitschman and Lindenthal, K. Jeppson, Kirshmeyer, and Bruett.) Gas gangrene infections after operations upon the intestines are also rare, under either septic or aseptic conditions. Brentano observed two cases and Flechtenmacher one case after herniotomies. He reports a case of gas gangrene of the abdominal wall and death 40 hours after operation for old existent appendiceal abscess with marked obstruction of the terminal ileum in which enterostomy at this point was performed at the same time. Autopsy revealed advanced gas gangrene of the entire abdominal wall and of the piece of ileum used for the fistula, the latter only as far as the muscularis was concerned. There was a large amount of hemorrhagic serum in the abdominal cavity, from which the *Clostridium welchii* was cultured as well as from the tissues.

Nason and Starr,⁷ in 1934, presented an excellent general discussion of the subject of "Gas Bacillus Infection Complicating Laparotomy" in which they state that the infection may begin in the muscle of the abdominal wall, the peritoneal cavity or the liver: that the pathologic changes are the result of the toxemia alone or plus the presence of organisms and gas.

Maguire,⁸ in 1934, says gas gangrene may occur subsequent to appendectomy, herniotomy and other operations performed on organs in close proximity to the intestinal tract, in which instances the causative organism gains entrance to the wound from the alimentary canal.

Finesilver,⁹ in 1934, in his discussion refers also to the studies of Weinberg and Seguin that the *Bacillus aerogenes-capsulatus* was in association with other bacteria, and states that the combined efforts of symbiosis of several species of bacteria are required to produce gas gangrene, the sacchar-

olytic group starting and the proteolytic group completing the destruction. The *C. welchii* elaborates a hemolytic toxin which produces further local destruction of tissues, and by absorption, remote constitutional symptoms.

C. Knapper,¹⁰ in 1929, presented a general survey of the subject, and comments that because gas edema bacilli and spores are found in the healthy gastro-intestinal canal, their development and toxin formation are especially to be feared in ileus. He refers to a fatal case of gas edema of the sigmoid under his personal observation but gives no details. Among the various ways of endogenic infection, he mentions by way of a typhoid or tuberculous ulcer of the intestine or through infection of the abdominal cavity itself with gas edema bacilli, after intestinal perforation.

All commentators agree that when the infection invades the blood stream, the peritoneum or the liver, the outcome is fatal. The consistent finding of extensive necrosis of the suprarenal glands may account for the rapid fall of the blood pressure, so characteristic of gas bacillus infection. A very high leukocytosis and an unusually rapid pulse, out of proportion to the temperature, or other findings, is the rule. That the *C. welchii* may reach the blood stream from any focus anywhere in the body is undoubted. That devitalized muscle is necessary for its growth and development in the tissues. That it may develop in the peritoneal cavity from perforation or operative soiling from the intestinal tract seems well proven. That toxemia from its development in the intestinal tract in cases of ileus may be quite profound even fatal.

Since there is muscle tissue in the wall of the intestine, is it not reasonable to assume that it may become traumatized and its blood supply markedly impaired by either strangulation as in a hernia or extreme overdistention from gas or other causes? Cannot such traumatized muscle itself become a site for the development of the *C. welchii*, from which site the organisms may permeate, rather than perforate, into the peritoneal cavity, and there produce gaseous peritonitis or may invade the blood stream for general dissemination? The toxins are so lethal, no large area of primary focus is required to produce a fatality.

Both cases, herein reported, would seem to qualify under these conditions as true cases of primary "gas edema" of the intestinal tract with gaseous peritonitis, since both showed gas bubbles in the musculature of the intestinal walls; one cultured the *C. welchii* from the peritoneal fluid and showed it in smears, the other (not cultured) showed the same characteristic chocolate or coffee colored foul peritoneal fluid; one had known trauma of the intestine with dynamic ileus (strangulated hernia) of seven hours duration, the other had an adynamic ileus of 12 to 15 hours duration, cause undetermined; one died apparently from a blood stream infection, possibly gas embolus, the other a typical death from gas bacillus toxemia.

Whereas, no gross perforations were apparent to the naked eye, it is perfectly possible that microscopic perforations may have been present in both cases. Such could have occurred by gas bubbles breaking through the

peritoneal coat from its point of origin in the muscularis and carried with it the organisms, since these have been shown to be present in the gas bubbles *in situ*.

Is it not possible that we are overlooking more of these cases by incomplete bacteriologic studies begun at the time of operation, by too few autopsies and failure to make bacteriologic studies in conjunction with the autopsy?

NOTE.—I wish to express my appreciation of the help of Dr. E. S. Sanderson, Professor of Bacteriology in the University of Georgia, School of Medicine, especially in looking up the literature and other suggestions.

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DISCUSSION.—DR. WILLIS G. GATCH (Indianapolis, Ind.).—A number of years ago I was asked to remove a node from the groin of a nurse who had arthritis. I did that under the most rigid aseptic technic but the pathologist reported a growth of *C. welchii*. This struck me as a very peculiar finding in a node not the seat of any particular inflammatory disturbance. You will remember that a few years ago there was considerable discussion in the literature following the work of Andrews of Chicago on bile peritonitis. I think that studies in our laboratory will go far toward clarifying this condition. These have shown that in the liver of old dogs there is nearly always present an anaerobic organism which cannot be distinguished from the *C. welchii* by the smear, but which is distinctly different in that it is not fatal to laboratory animals when injected intravenously. It is occasionally found in the liver of elderly human beings. In the muscle of dogs is found a similar organism, also non-pathogenic, but somewhat different from that in the liver. This is also found occasionally in the muscles of human beings. I think this organism is responsible in some cases for supposed *C. welchii* infection with no gangrene and followed by recovery.

The gas bacillus is present in the intestine of human beings, and I am inclined to believe that the cases reported by Doctor Rhodes are due to the true organism.

I saw a case of peritonitis from gas bacillus in which the abdomen was collapsed. One of our gynecologists had done an hysterectomy. The patient had not done well and about the third day I was asked to see her. The abdomen was tremendously distended, and the liver dulness absent. I was asked to operate, which I did under local anesthesia. As soon as I opened the abdomen it collapsed and the intestines were found deflated. The surgeon had removed the appendix before he performed the hysterectomy. I think when this is done one should always perform the hysterectomy first and the appendectomy afterward.

DR. H. J. BOLDT (New York, N. Y.).—Some 40 years ago I performed an ovarian operation upon a woman; on the second day I found the patient's abdomen very much distended. There was no rise in temperature but the pulse rate was increased. It did not seem to me from her appearance, with no elevation of temperature, that she had a peritonitis, and I asked my friend Doctor Garrigues what he thought about it. He said it was probably a gas bacillus infection and advised reopening the abdomen. This advice was followed and a large amount of gas escaped. We put a tube in and the patient made an uninterrupted recovery. I have not previously reported the case because no examination of the bacillus was made.

DR. CHARLES W. FLYNN (Dallas, Tex.).—In view of a very recent case of gas bacillus infection of the abdominal cavity, which came under my observation, I was very much interested in the report of Doctor Rhodes' cases. Gas bacillus infection of the gastro-intestinal tract or following operations on the gastro-intestinal tract has been very rare in my experience.

Case Report.—On November 13, 1935, a white male, aged 35, entered Baylor Hospital, complaining of nausea, vomiting, loss of weight and weakness for the past two and one-half weeks. For ten weeks he had complained of his stomach. The laboratory findings showed a low gastric acidity, positive Wassermann and Kahn tests, blood in the stools, and in the gastric contents. Physical examination revealed a general adenopathy, the heart was slightly enlarged, the lungs were negative. Blood pressure, 132/72. The abdomen was moderately distended with gas and there was tenderness over the epigastrium. The prostate was moderately enlarged and tender. There were external hemorrhoids. There were no pathologic reflexes. His general condition at this time was considered fairly good, although he had lost 15 pounds in the last 20 days. Gastro-intestinal roentgenologic studies revealed a lesion of the lesser curvature of the stomach, diagnosed as a carcinoma. Blood examination showed 6,300 white cells, 68 per cent polymorphonuclears. Hemoglobin was 66.9 per cent.

Progress.—While the patient was in the hospital he continued to vomit his meals. Temperature, pulse and respiration normal. He was placed on belladonna, 20 minims before meals, a bland diet and frequent feedings. His condition did not improve. However, he was still considered a good operative risk. After careful preoperative care, he was subjected to a partial gastrectomy. Two-thirds of the stomach was resected. Immediate postoperative condition, fairly good.

About 24 hours after operation the patient's condition became critical, with a rapid, thready pulse, shallow and rapid respiration, and slight cyanosis. He was given glucose intravenously, morphine and caffeine sodium benzoate hypodermatically, and was placed in an oxygen tent.

Physical examination showed numerous coarse râles throughout the lungs and his abdomen became markedly distended. The pulse increased, his temperature reaching 102° F., and he expired 36 hours after the operation. Nine hours after death a complete autopsy was performed by Dr. W. W. Brandes, with findings as follows: (1) Primary cause of death, gas infection (*C. welchii*). (2) Secondary cause of death, gastric resection for carcinoma. A brief synopsis of the autopsy report was: 1.—Recent gastric resection. 2.—Generalized fibrinopurulent infection—gas formation. 3.—Generalized invasion of body by gas forming organisms. 4.—Generalized hemolysis of blood. 5.—Generalized softening of tissues, especially the viscera.

DR. URBAN MAES (New Orleans, La.).—I should like to make one or two observations that bear on Doctor Rhodes' contribution. You will remember that when Dragstedt of Chicago planted free fetal liver in the abdominal cavity of animals there were no untoward results, though the typical picture of peritonitis followed when any but fetal liver was implanted, a

result that is highly suggestive. At present Dr. Frederick F. Boyce is conducting some experiments on autolytic peritonitis. All of the dogs in which he implanted liver, that had not been autoclaved, died promptly, with the typical picture of peritonitis seen under such circumstances. Two of the dogs, however, in whom we implanted liver, that had been sterilized (in one case unground and in another ground), both lived and showed no ill effects. Clearly the organisms described as *C. welchii*, or gas bacilli, are a normal inhabitant of the liver, and, equally clearly, they can be destroyed by sterilization.

From the clinical side, my own experience is that tachycardia is one of the most helpful diagnostic signs in this condition, often appearing before other evidences of the infection are manifest. I am always inclined to view, with grave suspicion, any patient in whom the circumstances are propitious for this type of infection and who develops a rapid pulse that cannot be otherwise explained.

It is unfortunate, as others have pointed out, that the term "gas bacillus infection" has come into such general use. It conveys a totally wrong impression. Doctor Finney will bear me out, as will any other surgeon with war experience, that when wounded soldiers exhibited gas in their wounds, it was frequently too late to do anything for them. On the other hand, when we saw them before crepitation was apparent, the prognosis was not always so hopeless.

DR. ROBERT L. RHODES (closing).—I think Doctor Gatch overlooked the fact that in the second case the *C. welchii* was demonstrated in the culture. It was the first case that made us proceed carefully in the second.

The point I wished to bring out is that such catastrophes should be very carefully investigated. Doctor Lahey reported yesterday two cases of gas bacillus infection from dilating the sphincter of Oddi. These occurrences are becoming more frequent and if we are to get anywhere we must keep their etiology in mind.

INGUINAL HERNIA

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WEBSTER defines rupture as a breaking apart or a state of being broken apart. The term rupture is objectionable since it implies an opinion as to the mode of formation. Hernia is a protrusion of a viscera from its cavity, and is the sequel of a congenital defect often made apparent by effort. Colcord¹ states that the fact that hernia is first complained of by the patient after an accident or a heavy lift does not prove that the accident caused the hernia. It discloses it to the patient, if he is honest, or if he is dishonest it affords him an opportunity to sell an old hernia to his employer. The profession has not properly impressed on the laity the knowledge developed by operation. It is now generally conceded by students of the subject that traumatic hernia can be caused only by direct violence producing a tear of the wall followed by a protrusion of the viscera at the point of violence.

The inguinal hernia is of two types, direct and indirect. It is quite apparent that the direct hernia has no connection with either the internal or the external ring, under which condition it is fair to assume that a weak posterior canal wall is responsible for direct inguinal hernia. In the etiology of indirect inguinal hernia, authors have considered the persistent processus vaginalis, the lax internal ring and the lax external ring. According to Halsted, the cord is the first cause of hernia, and the ultimate obstacle to its cure; that removal of a large part of the cord greatly facilitates its cure. Yet it has been conceded by many that the transversalis fascia is the sole important structure needed to retain the viscera within the abdomen. We believe that the external ring is in no way responsible for inguinal hernia. The large internal ring is the result of a weak posterior canal wall. The tissue above the internal ring takes no part in hernial formation and should not be sutured.

Brown² reports a case of a jockey whose horse fell on him. He became immediately ill with severe pain, vomiting and collapse. A few minutes later a typical small strangulated hernia was found and reduced by taxis. There was no previous history of hernia, yet subsequent operation demonstrated a small sac containing adherent omentum. Operative findings not infrequently demonstrate whether the hernia is recent or old.

Thirty-five years ago Russell³ discussed the persistent processus vaginalis and concluded that an oblique inguinal hernia never occurs independently of the presence of a congenital sac. His point is not well taken, else recurrence would not occur after proper removal of the sac. Dissections of inguinal canals without hernia have developed unobliterated sacs in about 25 per cent of the dissections. This also would lead us to believe Russell's point was not a valid one.

Bassini, in 1889, gave to the profession an operation that can be classed as a radical cure. Removal of the sac, which up to this time had not been attempted, was the keynote of his success. He attached the internal oblique transversalis muscle and conjoined tendon to Poupart's ligament, transplanting the cord over the newly formed pad, then suturing the divided aponeurosis, thus recognizing the posterior wall defect. Ferguson first severely criticized Bassini's transplantation, dropping the cord against the posterior wall, then followed Bassini's technic. Later Pitzman⁴ advised that the inguinal canal should be anatomically restored.

Andrews⁵ modified Bassini's operation, in that he retracted the internal oblique and transversalis muscle, suturing the transversalis fascia to Poupart's ligament. We believe that this is inadequate, since the fascia is normally thin medially to the iliac vessels and on account of the direction of the fibers will not hold a suture properly.

A number of surgeons have used the fascial suture since first advocated by McArthur,⁶ in 1902. It can be used only as a continuous suture in muscles sutured to fascia, which we believe inadequate.

We believe that the inclusion of muscles in hernia sutures is not warranted. The ease with which the aponeurosis is stripped from muscle should be proof enough that the muscle tissue will not permanently attach itself to fibrous tissue and since we became definitely convinced that a weak congenital posterior inguinal canal wall is responsible for both direct and indirect inguinal hernia, we developed a procedure in 1920 that has proved satisfactory.

Seelig,⁷ in 1924, drew attention to the fact that muscle tissue does not unite to fascia, when these two structures are coapted by suture, in the sense that fascia unites to fascia. His experiments developed the observation that when muscle masses are united to white fascia actual union occurs only between the white fascia and connective tissue elements forming the septa between bundles of red muscle tissue. It has been shown that fascia will unite to fascia under considerable tension; however, under spinal anesthesia, the abdominal muscles are completely relaxed and all tension is relieved by jack-knifing the operating table and is maintained by keeping the bed jack-knifed, plus adequate opiates, for the first week following the operation.

OPERATIVE TECHNIC.—The skin, superficial fat, and fascia are incised from above the abdominal ring to below the superficial ring, extending directly over the canal. By gauze dissection it is stripped from the external oblique aponeurosis. The superficial ring is cut with blunt scissors on its medial side and the aponeurosis slit to above the abdominal ring and separated from the deeper structures laterally, affording an excellent exposure of Poupart's ligament and medially the rectus sheath is exposed. The cord is next lifted from the floor of the canal close to the spine of the pubis. The entire content of the canal is lifted and dissected from its floor upward and outward to the abdominal ring. The hernial sac is next identified and opened. A finger is inserted in the sac as a guide when it is separated from the

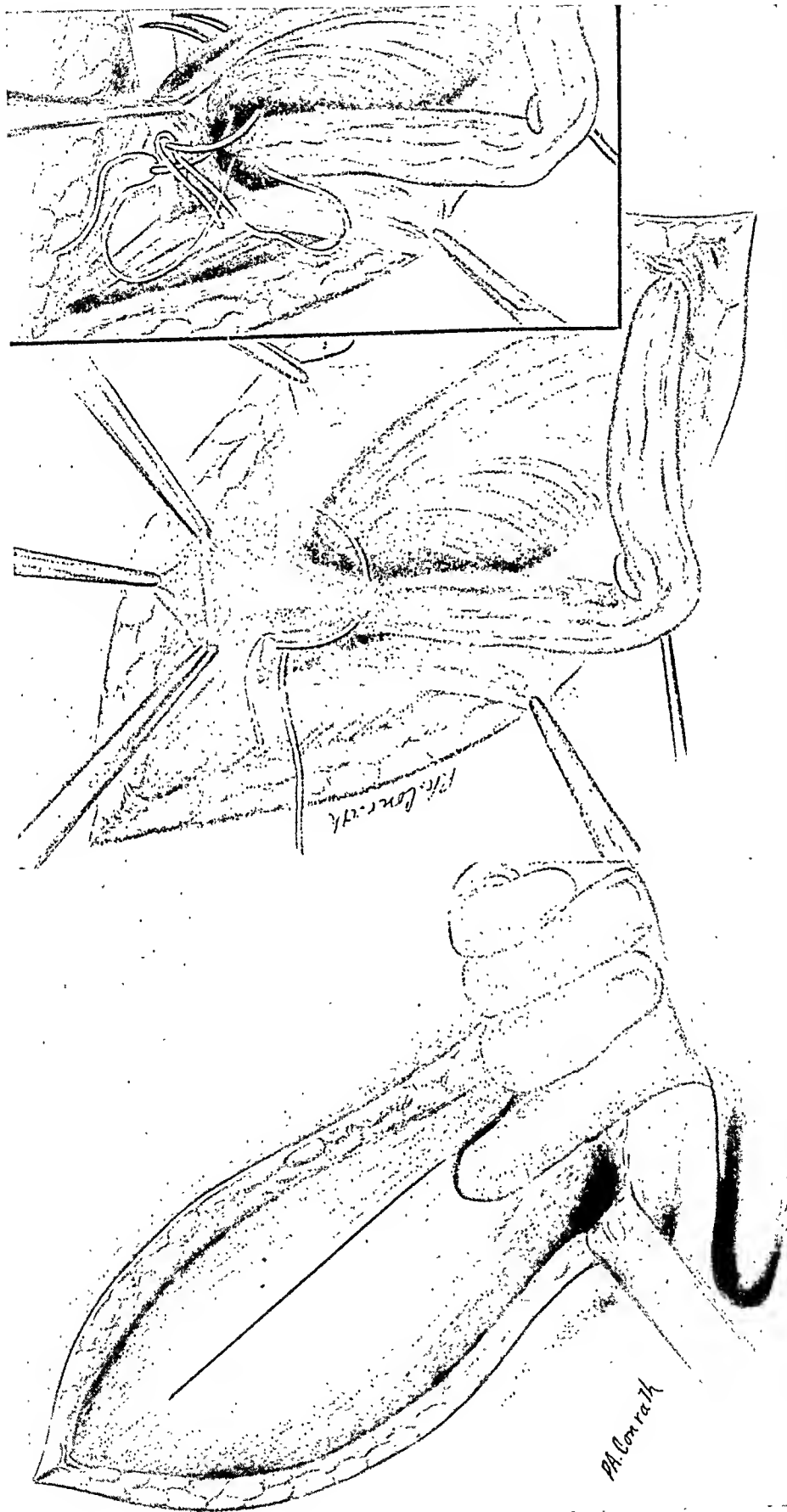


FIG. 1.—Showing position of incision through the external ring, on its medial aspect, and its continuation through the aponurosis above.

FIG. 2.—Showing lateral retraction of elements of cord, and transfixion of neck of sac. (Inset) —Method of dislocating neck of sac inward.

surrounding structures by gauze dissection. After it is free from the ring, it is transfixed, ligated and excised. The stump is carried inward and downward under the muscle and anchored by mattress suture, thus carrying the peritoneal dimple away from the posterior canal wall and anchoring it near enough the bladder to prevent a pull. As we believe the posterior wall is distensible and unstable in its entire length, we do not disturb but reenforce it in the following manner with double No. 1 20-day catgut: The first suture starting from without inward through the fascia lata, just below Poupart's ligament as closely as possible to the pubic spine grasping the conjoined tendon and returning from within outward through or just above Poupart's ligament where it is tied, leaving the knot external to the fascia. Each staggered suture is placed after the same manner three-eighths of an inch apart ex-



FIG. 3.—Showing technic of suture of conjoined tendon to Poupart's ligament, with knots external to the fascia.

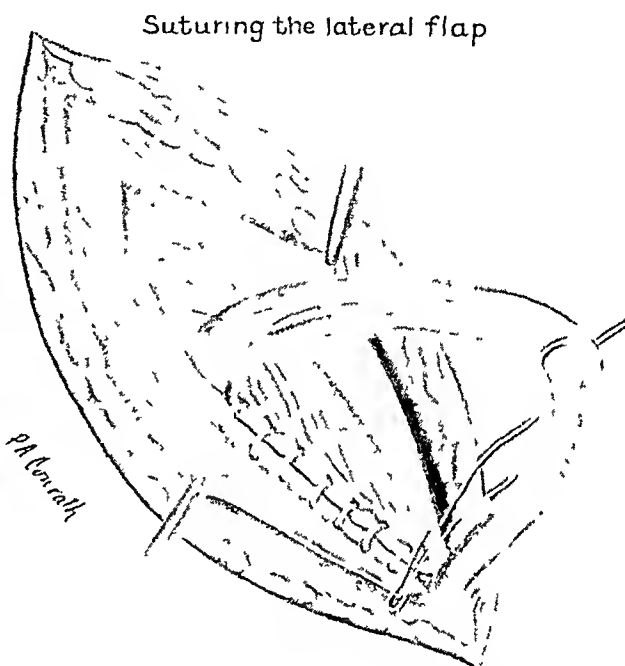


FIG. 4.—Method of imbrication of the aponeurosis of the external oblique

tending up the border of the rectus sheath as high as is necessary to cover the posterior canal wall, raising the cord a bit higher and giving it more angulation than formerly, closing the abdominal ring to the proper size. The elasticity of the muscle above the ring prevents strangulation of the cord. The lateral flap of external oblique aponeurosis is carried medially as far as possible and sutured to the deep side of the medial flap with a suture exactly similar to the first row, leaving the knots external to the fascia. The medial flap is now carried laterally and sutured either to Poupart's ligament or to the fascia lata. The skin and superficial fat are sutured with interrupted silkworm gut sutures about one inch apart, the needle entering the skin one-half inch from the margin and extending straight through fat. Above the internal ring the skin suture includes the fascia, thus obliterating space. The friction or surgeon's knot of three turns is used

to prevent puckering to secure proper approximation of the skin and to insure a flat comfortable knot.

We believe this method gives us an ideal posterior wall; that the arching of the internal oblique and transversalis above the abdominal ring gives us a perfect valve or sphincter and that the external ring which has been destroyed plays no part in the formation of hernia. Trauma to the transplanted cord has been mentioned; however, when we consider the flexibility of the abdominal wall, it is quite apparent that the only possible point of trauma is as it passes over the pubic arch, which region has not been disturbed. Our experience with reference to recurrence warrants our belief that the procedure is eminently satisfactory. The fact that we have for

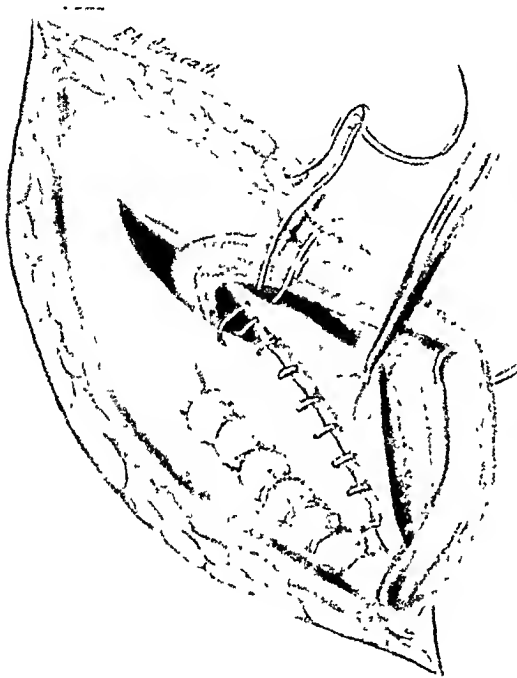
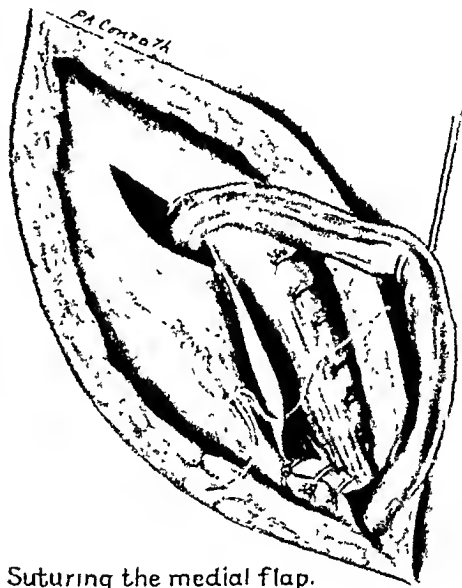


FIG. 5.—Extent to which imbrication in Fig. 4 is carried.



Suturing the medial flap.

FIG. 6.—Situation of final tacking sutures in the medial flap of the external oblique aponeurosis.

many years been connected with the Hospital Department of a large railway where hernia is especially common, and where the patients can return for operation because of recurrence without expense, leads us to believe that we would see more of our failures than the majority of surgeons.

This operation was originally reported before the Southern Medical Association in 1925, since which time we have personally performed more than 500 operations with but two recurrences. The first occurred following a postoperative pneumonia. The second recurrence followed operating upon a hernia, in which the entire posterior wall protruded well down under Poupart's ligament, which was found to be practically absent and fascia lata so thin as to be of little value. The patient was advised that recurrence was probable. This eventuated after three months. At time of reoperation so much connective tissue had been borrowed by Poupart's liga-

ment from the rectus sheath that the ligament was practically of normal density, and substantial repair was effected.

I have operated upon several recurrences during the past ten years, in cases originally performed by my assistants. In each instance the recurrence was at the abdominal ring. There is no question in my mind that the first suture line was not carried high enough in these instances.

The injection treatment of hernia originated with Velpeau 100 years ago. He used iodine in the attempt to obliterate the hernial sac. In Germany, Schwalbe in 1887 used alcohol, and it is unfortunately still used by many European physicians. Some years later the paraffin method was introduced and used for quite some time, finally being discarded by reputable surgeons, but it is still employed by quacks and charlatans. In the last five years much experimental work has been done with the injection method. It is claimed that the injection causes a proliferation of connective tissue which blocks the canal and prevents protrusion. Quite a number of different preparations have been used. In the advertising of one the statement is made that the technic of the injection method is easily acquired. In another, that it is not necessary that the treatment be administered by a surgeon. The talking point that the patient remains ambulatory, loses no time from his work and does not require hospitalization, has popularized the treatment both with the laity and the insurance companies. Regardless of the economical feature any patient would grasp at such a method rather than undergo a major operation. Only when a large number of surgeons use a certain method over a sufficient period of time can the true merit of the procedure be ascertained. I have had no experience with the injection procedure and only wish to warn of the possibility that this method might be taken up by quacks and medical cults, resulting in a great deal more harm than good.

CONCLUSIONS

(1) A congenital weak posterior inguinal canal wall should be considered responsible for inguinal hernia.

(2) The operative procedure detailed both removes the sac and reinforces the posterior canal wall, to a degree in considerable excess of the normal, as insurance against recurrence.

(3) The enthusiasts of the injection method possibly exaggerate its advantages and minimize the results of operation.

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⁴ Pitzman: *ANNALS OF SURGERY*, 1921.

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DISCUSSION.—DR. BRADLEY L. COLEY (New York, N. Y.).—Doctor Woolsey has referred to the large number of operations that have been proposed for inguinal hernia, which means that no one method is satisfactory and applicable to all types of hernia. In the small oblique hernia in young adults we feel that the Bassini operation is applicable and in our experience has given satisfactory results.

Dr. Carl G. Burdick, with whom I am associated at the Hospital for Ruptured and Crippled, began about eight years ago to divide the cord completely in large, neglected, scrotal herniae in men beyond middle life, and in a recent report gives the results in 200 such cases. Having divided the cord, the stump is allowed to retract into the abdomen, which permits of complete closure of the opening and thus eliminates a potential weak spot in the repair.

The indications for this radical procedure have been extended to include large sliding herniae, large scrotal herniae in the aged, which are either irreducible or cannot be satisfactorily retained by a truss, recurrent herniae in individuals over 50 with a normal testicle on the opposite side, where there have been one or more unsuccessful attempts at a radical cure, and finally recurrent herniae in younger subjects, who by reason of their recurrences are incapacitated from performing their occupations and where a perfectly normal testicle exists on the opposite side.

Direct hernia is a different problem, and here the traditional Bassini operation is apt to be followed by a high percentage of recurrences. For more than a decade we looked upon the repair by fascial sutures as the most satisfactory method of dealing with direct inguinal hernia. However, recently a careful study of end-results in approximately 1,200 such fascial suture operations revealed results which were far from realizing our hopes and expectations, so that in the last year or two we are performing this operation much less frequently.

The use of silk for ligatures and sutures was undertaken with some misgivings, as our policy in the past always tended to avoid non-absorbable material at all times. During the past two years, however, the silk technic has steadily displaced the use of other suture materials, and we are convinced that by employing it we have greatly lowered our percentage of infection and improved the operative results. Whether this can be attributed solely to the use of the silk or to the meticulous care in handling the tissues and securing absolute hemostasis and accurate coaptation, which is an integral part of the silk technic, I do not know.

Finally, a word about the injection treatment of hernia. About a year ago we felt that this method should be investigated, because of the voluminous reports of its successful employment in the hands of others. Accordingly, in November, 1934, we commenced to use the injection method, and employed it in some 50 cases. Several injection fluids were tried, including Pina Mestre, Galtanol, Proliferol and O'Malley's Solutions. The immediate results during and following the course of injections in many instances were most encouraging and for a time we were quite enthusiastic. Following the removal of the truss and with the lapse of time, in a high percentage of cases which at first seemed to be controlled, it was found on subsequent follow up examination that the hernia was still present. The uncertainty of the method, the prolonged period of treatment and observation, the necessity for wearing a large uncomfortable truss night and day for a prolonged period, and the occasional development of a hydrocele following the injections prompted us to discard it almost entirely.

DR. ADRIAN S. TAYLOR (Clifton Springs, N. Y.).—I investigated all hernia operations done in the Johns Hopkins Hospital, with regard to recurrence, in the cases in which operation had been done in Doctor Halsted's clinic during the second 20 years of its existence. Doctor Bloodgood had reported the results during the first 20 and, strange to say, I found exactly the same results. In indirect hernia, the average time of recurrence in a large series was 48 months after operation, while in direct hernia, recurrence was found to occur within the first year. In all operations for hernia there was an average recurrence of 5.6 per cent in indirect cases, and 18 per cent in direct. I agree thoroughly with the essayist that an important cause of recurrence, in all cases of hernia, is to be found in a weak posterior inguinal canal wall. Doctor Halsted very early pointed out a method of strengthening this wall which obeys all the requirements for plastic surgery. I refer to his method of drawing the cremasteric muscle and fascia up underneath the conjoined tendon, as the first layer in the closure. By so doing the transversalis fascia is also strengthened.

I am delighted to hear my friend from New York speak of the use of silk. I wish to refer to a sentence in an article by Cushing, which appeared in *Science* after the death of Doctor Halsted, in which he said, "He showed how silk could be safely buried in the tissues, an important principle many surgeons are incapable of learning." Now, after so many years, there is an increasing appreciation of the exquisite technic taught by Doctor Halsted, which is perhaps dependent upon the use of a fine, easily sterilizable suture material.

Doctor Woolsey has said that infection produces fibrosis. During the first year of the Johns Hopkins Hospital six hernia operations were performed by Doctor Halsted's resident, who used the old McBurney technic, in which the sac was tied off and the wound packed with gauze and allowed to heal by granulation. In these cases there was prompt recurrence in 50 per cent. The same high percentage of recurrence was found in those cases in which infection occurred. Here, of course, fibrosis was extreme. In the injection treatment, fibrosis must be depended upon, and if temporary cure be attained, the incident of subsequent recurrence must be high.

DR. GEORGE A. HENDON (Louisville, Ky.).—I have always approached the problem of hernia on the principle of a plastic operation, keeping prominently in view certain underlying principles, upon which success depends: (1) The extent of denuded areas that are in apposition. (2) The amount of tension that is necessary to secure the contact. In order to meet with the first requirement of bringing broad surfaces together, mattress sutures of kangaroo tendon are carried through the conjoined tendon and aponeurosis of the external oblique jumping over the canal and including Poupart's ligament and the adjacent fascia. The position of the cord is not disturbed. When the sutures are tied, fascial inversion with broad contact is secured. I think that by emphasizing this plastic principle we add a great deal to the security of the operation. It applies in all forms of hernia.

DR. JOHN T. MOORE (Houston, Tex.).—I have been highly instructed by the dissertations on hysterectomy and hernia, but where have we gotten as a group? Each man has presented something worth while. I have always looked upon this Association as a great clearing house for surgery, to have it presented and approved so that the mass of those doing surgery in the country could profit as we have done as a group. To take a lesson from the oil people: they have had the problem down in our country of

drilling through heaving shale. They have found a method that was successful, because their engineers have now compared their work and have gotten together. In other words, by comparing methods, a standard of operations puts them through heaving shale by the best known methods. Is it not possible that this organization, the American Surgical, and other Associations could work out a plan whereby an hysterectomy, total or subtotal, or hernia operation, in this way or that way, could be done by a somewhat standardized technic—one accepted by the best surgeons?

I am also glad to know that many men outside of Johns Hopkins have learned that fine silk, in clean wounds, is one of the best suture materials we have ever had. Still, we go all around the country and see our surgeons talking about a lot of things that it seems to me have been settled for a long time.

DR. W. D. WISE (Baltimore, Md.).—I was interested in this paper on hernia because we have had a feeling for a long time that fascia to fascia repair is a great improvement over the results of sewing muscle to fascia, although that is done also, because to bring down the internal oblique and the transversalis to Poupart's ligament is the logical thing to do. However, the plan presented by the essayist gives a fascia to fascia approximation that I think will, in most instances, do away with the necessity of the Gallie operation or similar procedures.

The operation we have been performing since 1919 is quite similar to that of the essayist. We, however, carry our sutures a little higher under the cord, making the cord point more obliquely, which increases the valve effect. I would suggest to Doctor Woolsey that, as he carries his suture through Poupart's ligament, he go down and pick up the pectineus fascia, thus helping to prevent a femoral hernia. In the repair of inguinal hernia there is sometimes a tendency to open up the femoral canal. Several years ago I demonstrated a suture intended to prevent this.

In some cases when the sac has been dissected down to the deep ring and one reaches the point where an attempt has been made by nature to close it but has not succeeded, if the finger is put through the neck of the sac and lifted slightly, one will find another potential sac there, something like a saddle-bag hernia but lateral to the inferior epigastric artery. I do not see why this would not be an element in a certain number of recurrences of hernia. This can easily be removed along with the sac. I always look for it and in quite a percentage of cases it is found and removed.

DR. R. A. WOOLSEY (closing).—I have very little to say, other than that on one occasion many years ago in Chicago at Dr. Albert Ochsner's Clinic, I heard him comment on a recent article on hernia written by a New York surgeon quoting his percentage of recurrence. He remarked that this man had very little chance of knowing of the majority of his recurrences, since they went to other surgeons for operation, and that he himself had quite recently operated upon four of the author's recurrences.

I believe the most important step in a hernia operation is the fascia to fascia imbrication as set forth in this procedure.

SURGICAL TREATMENT OF GIANT CELL TUMOR

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AN HISTORIC study of giant cell tumor of bone shows that the treatment of this condition has followed closely discoveries in the fields of pathology, roentgenology and radiology. Among those who have contributed prominently to our knowledge are: Astley Cooper, Lebert, Paget, Nelaton, Virchow, Koenig, Hinds, Bloodgood, W. B. Coley, Ewing, Codman and others.

Before the beginning of the present century, amputation was the usual treatment since these cases were seldom distinguished from the malignant bone sarcomata. With the advent of roentgenology, however, the distinctive appearance of the giant cell tumor, together with the characteristic microscopic features, made it possible to recognize the process as a distinct entity. Bloodgood (1910) and W. B. Coley (1907) were the first of the present day writers to advocate conservative treatment, warning against amputation as an unnecessarily radical procedure. One way in which Bloodgood accomplished his purpose was to insist upon dropping the term giant cell sarcoma and substituting that of benign giant cell tumor. The method he advocated was: curettage and cauterization with an escharotic, such as phenol. Curettage of the benign giant cell tumor was probably first performed by Koenig, about 1894. Hinds (1895) first combined curettage with chemical cauterization of the cavity and established this method as a curative measure. His case was traced and known to be well 26 years later. Bloodgood, in 1923, gives his own experience with curettage and cites cases so treated by more than a dozen other American surgeons.

Irradiation therapy came into general use about two decades ago in the treatment of all forms of malignant disease, so it was natural enough that it should be tried for giant cell tumor. Herendeen was among the first to demonstrate its effectiveness and to show that cures can be obtained in many of these tumors. Other roentgenologists quickly followed the lead, and now the treatment by roentgen ray has, in some localities, largely superseded surgical measures.

It is admitted that surgical treatment of a few decades ago, while often successful, not infrequently resulted in infections, sinus formation and fungation of tumor tissue which occasionally necessitated an amputation. The chief reasons for these bad results were threefold, *viz.*: (1) An exploratory operation was often done first with removal of only sufficient tumor tissue for biopsy, or the operator failed to remove all tumor tissue by curettage because exposure was often inadequate, and hemorrhage frequently so alarming as to cause him to desist before achieving complete extirpation. (2) The practice of packing the bone cavity with gauze frequently led to secon-

dary infection and fungating wounds, for when, to an inadequately removed giant cell tumor, secondary infection is added, the result is quite likely to be eventual loss of limb. (3) Failure to use chemical cauterization after curettage is another explanation of recurrences, because cauterization of the cavity wall destroys any small remaining traces of tumor tissue.

We shall attempt to show why we believe properly performed surgical treatment gives superior results in accessible tumors of the long bones, and in particular, of the weight bearing long bones.

Fortunately, the surgical picture has changed. About ten years ago one of us (Coley) suggested the importance of immediate closure of the wound without drainage or packing after curettage for giant cell tumor. Striking improvement in end-results was noted, and the procedure soon became routine on the Bone Tumor Services at the Memorial Hospital and at the Ruptured and Crippled Hospital. Further technical changes included the use of a large enough window to permit thorough curettage of the entire cavity under direct vision; rapid removal of tumor tissue and the use of a tourniquet to minimize hemorrhage and to prevent obscuring the field during the curettage. These measures were reinforced by a most rigid preoperative skin preparation.

That the method has yielded satisfactory results is shown by the following. In the last 21 operations upon 20 consecutive cases treated surgically, wound healing by first intention resulted in every instance with the exception of one recent case with an infected sinus, from operations performed elsewhere, in which we were unable to obtain primary closure of the wound. Four of these cases were recurrent when operated upon, the primary operation having been done elsewhere. A fifth recurred after the first curettage, but is apparently cured by the second. With the exception of one recurrent case that showed evidence of malignant degeneration after a second curettage and died of pulmonary metastases following amputation, all of the remaining 19 cases are now well, have good function of the adjacent joint and are free from symptoms. In each instance repair is demonstrated by roentgenogram to be adequate. In only one case was there evidence of pathologic fracture after curettage; this patient was hurt in an automobile accident.

BRIEF REPORTS OF 20 CONSECUTIVE CASES TREATED SURGICALLY

Case 1.—D. C., male, aged 39. Admitted to Memorial Hospital July 8, 1931 with a history of slight swelling in the right knee and tenderness over the inner condyle of the femur. Roentgenograms showed a giant cell tumor of the lower end of the right femur and aspiration biopsy supported the diagnosis. Operation July 15, 1931. The diseased area was curetted and cauterized and a circular plaster case applied. The splint was removed two months later and a walking Thomas caliper worn for four months. Since then he has been able to get about without any support, is symptom free and has full function of the knee. Last seen September 25, 1935, more than four years after operation.

Registry No. 1305: Giant Cell Tumor.

Case 2.—W. P., male, aged 26. Admitted to Memorial Hospital August 6, 1931, with a history of pain and disability in the left knee of two years' duration. Roentgenograms

GIANT CELL TUMORS

showed a giant cell tumor of the upper end of the left tibia. Operation September 3, 1931. The diseased area curetted and cauterized. The wound was closed above a small strip of gauze packing at the lower angle. Two roentgen ray treatments had been given the previous week (500 r units medial and lateral). The leg was kept in a plaster case for six weeks and Coley's toxins administered. He was able to walk without support two months after operation, returned to work as a chauffeur three months after operation and has shown normal range of motion since. Last seen April 17, 1935, more than three and one-half years after operation.

Registry No. 1303: Giant Cell Tumor.

Case 3.—G. O., male, aged 44. Admitted to Memorial Hospital July 1, 1931. He had been treated in July, 1930, for a fracture of the femur sustained from a fall. He refractured his femur in November, 1930, when his crutch slipped. In April, 1931, after another fracture, a cyst was diagnosed and he was given ten roentgen ray treatments without improvement. On admission to Memorial Hospital the roentgenograms showed an extensive giant cell tumor of the lower end of the left femur. Operation July 15, 1931. The diseased area was curetted and cauterized and the limb supported in a plaster case for two and one-half months. Eleven injections of Coley's toxins were given. Weight bearing was begun six weeks later. He was able to walk without support seven months after operation. Since then he has had a range of motion from 180° extension to 90° flexion, with no symptoms. Last seen September 30, 1935, more than four years after operation.

Case 4.—E. B., female, aged 31. Admitted to Memorial Hospital June 10, 1933, with a history of fracture above the left knee sustained three years previously and resulting in 4 cm. shortening and disability. Roentgenograms showed a giant cell tumor of the lower end of the left femur. Operation June 26, 1933. The diseased area curetted and cauterized. A plaster case was applied for three weeks; then a walking Thomas caliper for six months. At last examination, September 4, 1935, she had a one-quarter inch raise on her heel, walked with a barely perceptible limp and showed a range of motion at the knee from 180° extension to 85° flexion.

Registry No. 1539: Giant Cell Tumor.

Case 5.—H. G., male, aged 22. Admitted to Memorial Hospital May 25, 1931, with pain in the knee of six months' duration. Roentgenograms showed a large giant cell tumor in the upper end of the left tibia. Operation May 27, 1931. The diseased area was curetted and cauterized. He was discharged from the hospital in two weeks and could walk without support and without a limp three weeks after operation. He showed no limp or deformity and could extend to 180° and flex to 90° when last seen, November 6, 1935, four and one-half years after operation.

Registry No. 1296: Giant Cell Tumor.

Case 6.—M. L., male, aged 44. Admitted to Memorial Hospital November 8, 1933, after operation at another hospital in August, 1933, for giant cell tumor of the upper end of the right tibia. As symptoms persisted he was again operated upon November 11, 1933, curettage and cauterization being performed. Giant cell tumor was reported by the pathologist. Symptoms of pain persisted and an aspiration biopsy was performed which revealed a malignant tumor. The leg was amputated January 6, 1934, and a tumor thrombus found in the femoral vein. Microscopic sections showed malignant sarcoma. There was an early recurrence in the stump and pulmonary metastases by May 16, 1934. Patient died July 20, 1934, one year after his first operation.

Registry No. 1697: Giant Cell Tumor.

Case 7.—T. B., male, aged 15. Admitted to Memorial Hospital October 3, 1930, after curettage and cauterization of a giant cell tumor of the lower end of the right femur at another hospital in July, 1930. He had had pain in the right knee for one month prior to operation. He was given a course of Coley's toxins and the plaster case removed three

months after operation. Since then he has been symptom free and has full function of his knee. Last seen August 7, 1935, more than five years after operation.

Registry No. 1698: Giant Cell Tumor (malignant).

Case 8.—A. W., male, aged 40. Admitted to Memorial Hospital May 9, 1930, with a history of "rheumatism" for 13 weeks. Roentgenograms showed giant cell tumor of the upper end of the right tibia. He was given three cycles of roentgen ray therapy, using two ports, in May, June and the following January. Operation February 25, 1931. Curettage and cauterization were performed and were followed by primary wound healing. He was discharged from the hospital in six weeks and had return of full function of the knee in four months. Last seen April 17, 1935, with full function and symptom free, more than four years after operation.

Registry No. 1382: Giant Cell Tumor.

Case 9.—M. D., female, aged 17. Admitted to Memorial Hospital June 19, 1935. Roentgenograms showed giant cell tumor of the upper end of the right tibia of the epiphyseal chondromatous type of Codman. Operation June 26, 1935. Curettage and cauterization were performed and followed by primary union. She walked well without crutches in two and one-half months. At last examination, November 27, 1935, she could flex the knee to 85° and extend it to 175°, and walked without any limp four and one-half months after operation.

In process of registration.

Case 10.—W. M., male, aged 30. Admitted to Memorial Hospital July 14, 1935, following three operations for giant cell tumor of the upper end of the left tibia. There was a draining sinus at the time of admission, but as the tumor had evidently been incompletely removed, operation (curettage and cauterization) was performed July 24, 1935. The pathologic report was aggressive giant cell tumor. Primary wound closure was attempted under tension, but the wound separated and left a discharging sinus. He last reported (October 8, 1935) that the wound was still draining.

Case 11.—J. L., female, aged 11. Admitted to the Ruptured and Crippled Hospital October 12, 1931, with a history of pain and swelling of the right knee for six weeks. Roentgenograms showed giant cell tumor of the upper end of the right tibia. Curettage and the cavity packed by another surgeon October 19, 1931. The tumor recurred and on February 1, 1932, a second operation was performed—curettage and cauterization. This was followed by a series of Coley's toxins. There was normal function of the knee in two months and she was symptom free with full function of the knee when last examined, February 25, 1935.

In process of registration.

Case 12.—L. L., female, aged 13. Admitted to the Ruptured and Crippled Hospital November 4, 1932, with a history of pain and swelling in the right wrist of ten months' duration. Roentgenograms showed a giant cell tumor of the lower end of the right ulna. On November 7, 1932, curettage and cauterization were performed and the wound healed per primam. This was followed by a series of Coley's toxins. When examined a year later she was symptom free and had full function of her wrist.

Registry No. 1706: Giant Cell Tumor.

Case 13.—E. B., male, aged 41. Admitted to the Memorial Hospital January 18, 1929, following curettage at another hospital. The wound had been packed and was infected. It required five months to sterilize the cavity sufficiently to skin graft, after which healing was complete and the leg was in excellent condition. He moved out of the city, but reports frequently by letter that his knee is as good as the other one. His last letter was August 22, 1935, nearly seven years after operation.

Registry No. 1086: Giant Cell Tumor.

Case 14.—R. P., male, aged 37. Admitted to the Ruptured and Crippled Hospital April 18, 1928. He had had an amputation of the left leg November 30, 1920, presumably

for osteomyelitis. He had had pain in his right knee for five months prior to admission to the hospital. Operation April 20, 1928. Curettage and cauterization. He was given a series of Coley's toxins and was then transferred to the Memorial Hospital for radium treatment. He was given 32,000 mg.h. with the radium element pack at 10 cm. distance in June, 1928. He has remained symptom free and was reported in good condition on December 6, 1934, more than six and one-half years after operation.

Registry No. 896: Giant Cell Tumor.

Case 15.—J. S., male, aged 29. Admitted to Bellevue Hospital April 13, 1935, with a history of pain in the right hip of six months' duration. Roentgenograms revealed giant cell tumor of the upper end of the right femur and on April 20, 1935, curettage and cauterization were performed and a plaster spica applied. The spica was removed four months later and the patient fitted with a walking Thomas caliper. He was seen November 22, 1935, the wound had healed per primam and there was good range of motion at the hip. Roentgenograms showed good calcification in the cavity, but because of the size of the original tumor the patient was advised to continue to use his caliper splint.

Case 16.—R. L., female, aged 26. Admitted to the Ruptured and Crippled Hospital September 18, 1934, with a history of pain in the right knee (diagnosed giant cell tumor and operated upon one year ago at another hospital). She had recently fallen and injured the affected knee and on admission roentgenograms showed a pathologic fracture with depression of the medial condyle of the tibia. Traction was tried; then a plaster encasement; but symptoms persisted. Operation, November 26, 1934. The involved area in the upper end of the right tibia was curetted and cauterized. The wound healed by primary union and a series of Coley's toxins was given during convalescence. A plaster case was applied for three months; then a walking Thomas caliper, which she still wears. When last examined (November 27, 1935) patient was symptom free and the range of motion at the knee was from 180° extension to 135° flexion.

In process of registration.

Case 17.—P. O., male, aged 38. Admitted to the Ruptured and Crippled Hospital July 5, 1932, with a history of pain in the left knee of three months' duration. Roentgenograms revealed a giant cell tumor of the lower end of the left femur. Operation, July 11, 1932. The involved area was curetted and cauterized, and in four months he was able to walk without support and was symptom free. Following a local injury his symptoms returned and the area was again curetted and cauterized February 18, 1933. He was then given a series of Coley's toxins. He remained well with good function of the knee until September 18, 1934, when he fractured his femur through the involved area. He was treated in Russell traction for two weeks and then wore a plaster spica for two months. He then used a walking Thomas caliper for six months. When last seen (December 4, 1935) he was symptom free, had good function of the knee, and roentgenograms showed good bone regeneration in the cavity.

In process of registration.

Case 18.—A. S., male, aged 16. Admitted to the Ruptured and Crippled Hospital June 22, 1930, with a history of pain and swelling of the right ankle of 12 months' duration. He had been operated upon at another hospital in January, 1930, but his symptoms had recurred. Roentgenograms revealed a giant cell tumor of the lower end of the right tibia—recurrent. Operation, June 24, 1930. Curettage and cauterization, the wound healing by primary union. December 7, 1935: patient free of symptoms; has perfect function of ankle.

Case 19.—C. K., male, aged 23. Admitted to Lincoln Hospital March 19, 1935, with a history of swelling in the right ankle following a kick. Roentgenograms revealed a large area of cystic degeneration in the lower portion of the right tibia. Operation, March 23, 1935. Curettage and cauterization were performed, the wound healing by primary union. Pathologic Report: Benign giant cell tumor. December 3, 1935: wound

is well healed. The external appearance of the ankle is almost normal and the motions of the ankle are normal in all directions. There are no symptoms. Result functionally, anatomically and economically excellent.

In process of registration.

Case 20.—J. L., male, aged 15. Admitted to Lincoln Hospital March 30, 1935, because of pain and swelling on the dorsum of the left foot. History of injury to foot against a bench four months prior to admission. Examination showed a swelling over the dorsum of the left foot at the base of the second and third toes. Roentgenograms revealed a large cystic swelling, expanding the distal two-thirds of the third metatarsal. Operation, April 1, 1935. Resection through the base of the third metatarsal bone with removal of tumor mass, the wound healing by primary union. Examination (December 4, 1935) revealed that the wound was well healed, and that patient walked without limp. Wore foot plate for support of transverse arch. Result satisfactory.

In process of registration.

Indications for Surgical Treatment.—In general, it may be stated that giant cell tumors occurring in bones inaccessible to surgical approach should be treated by irradiation. Tumors of the ulna and fibula, if quite extensive, are amenable to resection, without great sacrifice of function, and with assurance of successful end-result. Tumors of the upper end of the femur are not always readily accessible to curettage and the operation may be quite difficult; irradiation may therefore have to be employed in this location. Tumors occurring in the lower femur and upper tibia seem to us to be particularly adapted to curettage. They are accessible, the functional result is excellent, the period of disability is shortened with obvious economic advantages, and pathologic fracture is avoided. We find that pathologic fracture has complicated approximately one-fourth of our giant cell tumors of the long bones treated by irradiation.¹ This high incidence doubtless could be cut down by greater restriction of activity and more careful splinting and protection during the prolonged period often necessary for bone regeneration following roentgen ray therapy. But it has been our experience that where pathologic fracture has occurred, joint function usually suffers permanent impairment.

The effect of therapeutic doses of roentgen ray on joint structures, especially synovial membrane, but also muscle and fascia, has never, so far as we know, been studied experimentally. Clinically, however, we have seen a number of cases in which irradiation has produced obvious permanent damage to skin and underlying soft tissues. No doubt the dosage has been modified in more recent years so as to render these sequelae less frequent. Yet the amount of irradiation required to control the giant cell tumor has never been established and no doubt varies with individual tumors and probably is influenced by the age of the patient, rate of growth of the tumor, location in bone and especially its vascularity. Dosage is still a matter upon which wide variation of opinion exists, but it seems safe to say that doses formerly employed were generally excessive and too often repeated. It is certainly wiser to err on the side of under treatment. Excessive doses

may completely inhibit bone regeneration and even lead to eventual amputation.

Selection of Type of Treatment.—It is apparent that roentgenologists as a rule prefer irradiation, while surgeons favor curettage. Pathologists, who are more apt to see the unfavorable results of cases treated by both methods, are divided in their opinions. It is our conviction that unless one has had an opportunity to see a considerable group of cases treated by both methods,

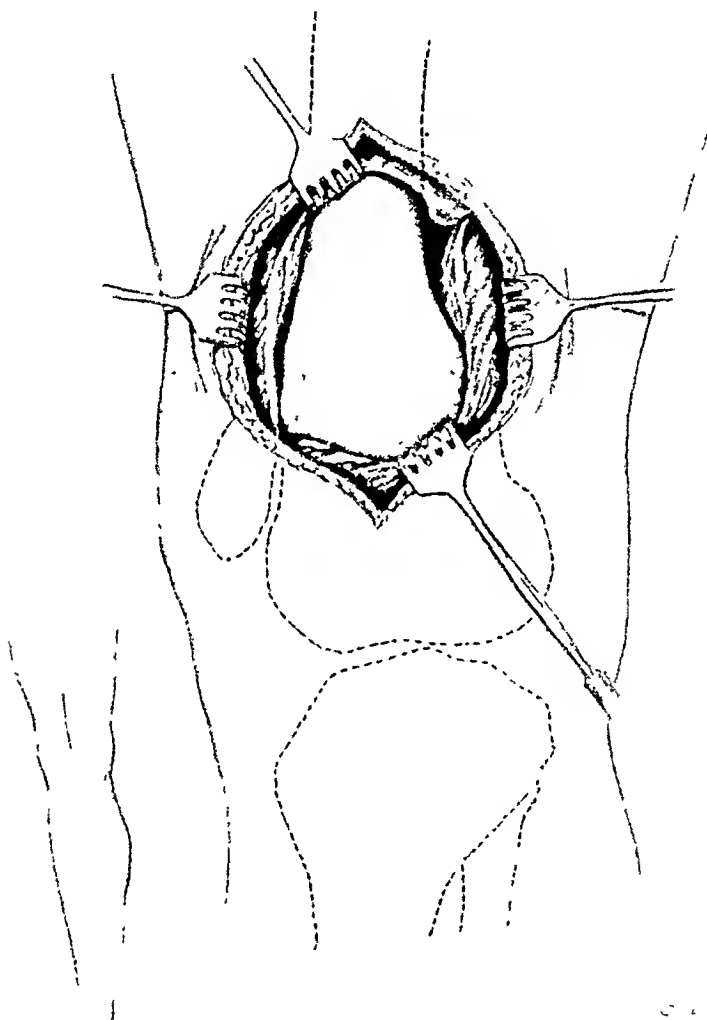


FIG. 1.—Shows exposure of involved portion of the femur with retraction of, rather than division of, the muscles.

singly and in combination, to follow them for years and to treat the complications and sequelae that arise, he is scarcely in a position to decide upon their merits.

Operative Technic.—Having decided that a given case is suitable for operation, our procedure is as follows. The skin is prepared as painstakingly as for any open bone operation; we prefer a 48 hour preparation. Provision is made for transfusion immediately after operation, in case undue loss of blood creates the necessity for it. Under general anesthesia (gas-oxygen or avertin) and using a tourniquet the skin incision is made over

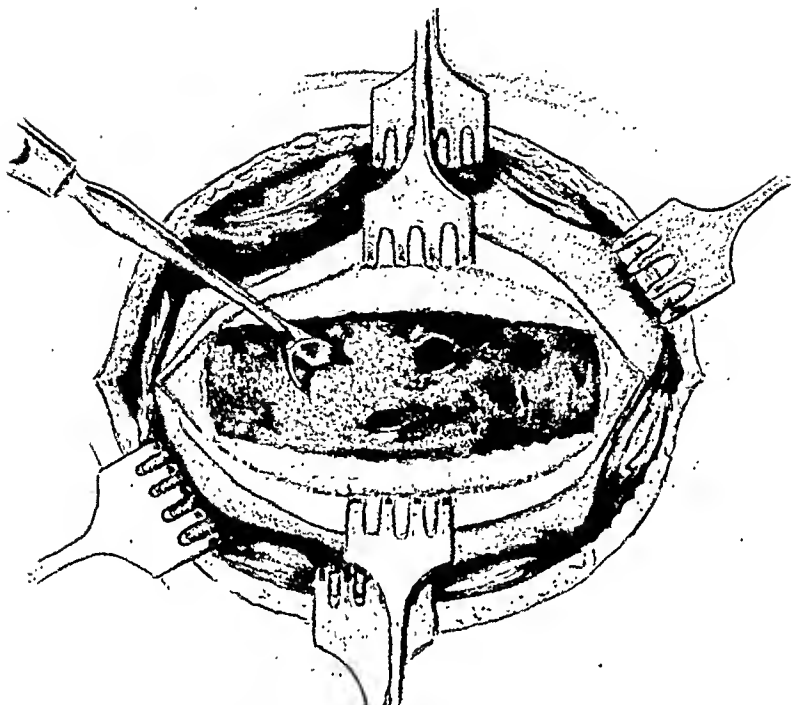


Fig. 3.—Shows window enlarged by rongeur and curettage of tumor tissue being carried out.

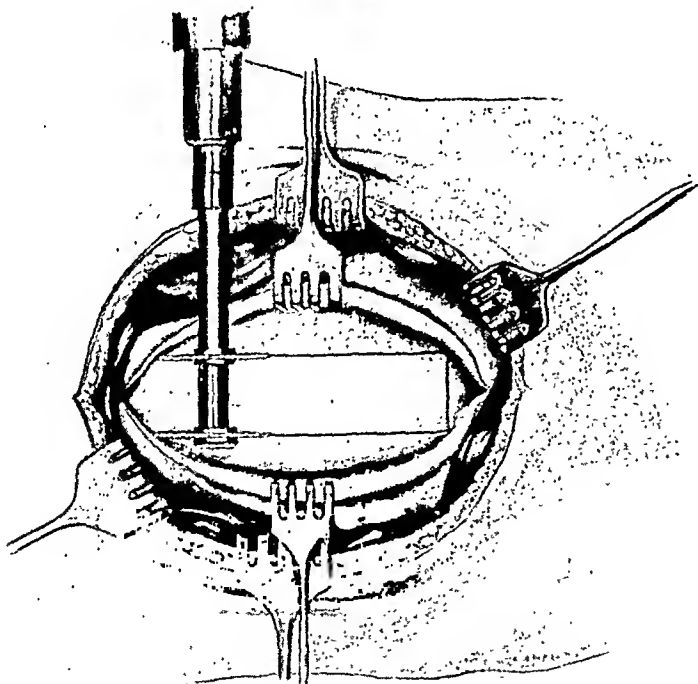


Fig. 2.—Shows periosteum divided and retracted and window of cortical bone outlined by motor saw. This step can be done with an osteotome and, where the shell is very thin, sometimes by knife or heavy scissors.

GIANT CELL TUMORS

the tumor bearing portion of the bone. The selection of the exact site of the incision and care in avoiding the neighboring joint cavity are matters of importance.

The incision passes down to periosteum through fascia and muscle, splitting rather than dividing the latter whenever possible (Fig. 1). The periosteum is divided and stripped back to expose the area of cortex which is to be removed for access to the tumor. A rectangular window is then made by an osteotome or twin-bladed motor saw (Fig. 2). The window is then enlarged with a rongeur until a thorough curettage can be performed under direct vision, aided by palpation (Fig. 3). No unnecessary sacrifice of cortical bone should be made. To assist in getting at the roof of the

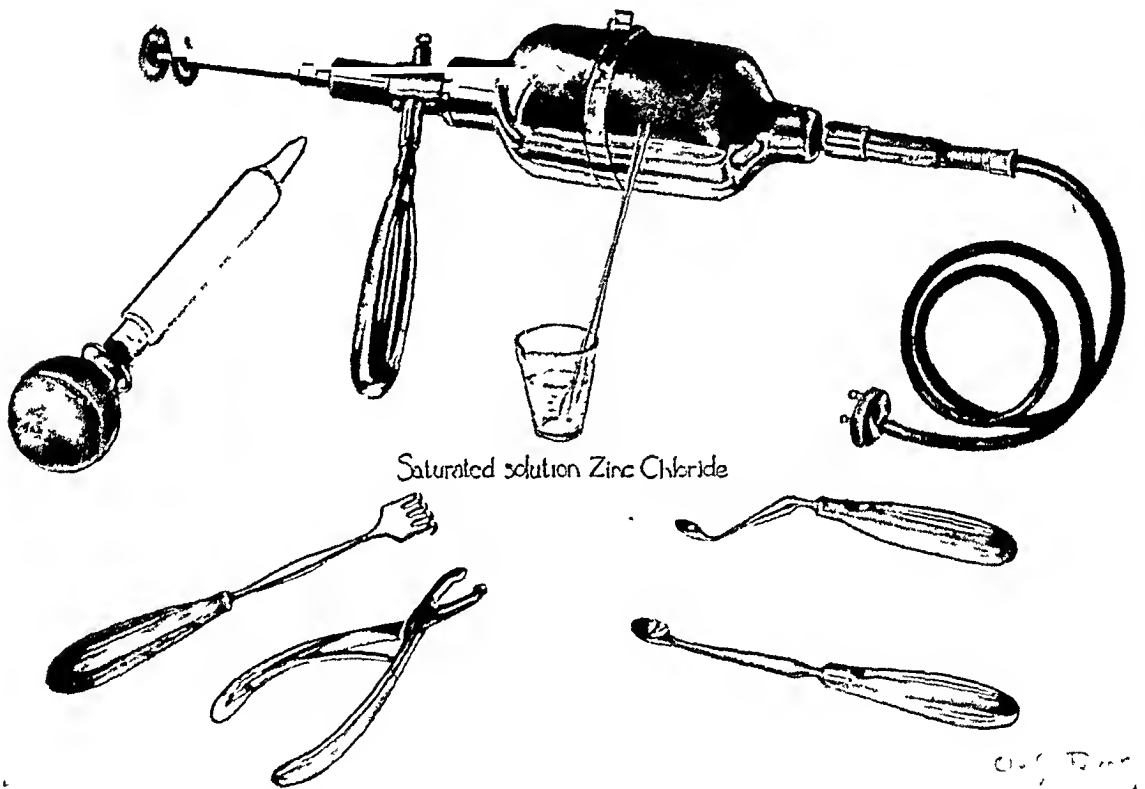


FIG. 4.—Instruments useful in the surgical treatment of giant cell tumor.

cavity and to insure complete removal of all particles of tumor tissue and cancellous bone, it is helpful to use a curet with an angular handle (Fig. 4).

Tumor tissue is thus rapidly, but carefully, curetted and the cavity repeatedly flooded with Dakin's solution or normal saline solution. When the surface of the bone cavity is clean, the interior is thoroughly swabbed out with a saturated solution of zinc chloride (or, if this is not available, with pure phenol followed by alcohol), which is allowed to remain in contact with the bone for about one minute, care being taken to protect the soft parts from contact with the escharotic solution, which is then flushed away by flooding the cavity with Dakin's solution. Periosteum, muscle, fascia and skin are closed in separate layers with interrupted sutures without drainage.

We do not favor the stuffing of the cavity with bone chips, for the bone shell usually possesses sufficient regenerative power to restore continuity. Fine silk is used for the skin, with care to maintain accurate approximation. The tourniquet is removed and a bulky gauze dressing with sterile sheet wadding and snug flannel bandage is applied. Plaster encasements or splints are used where indicated. For the first 72 hours after operation the part is kept elevated. When the skin sutures are removed, the wound is redressed, still maintaining moderate pressure as at the initial dressing. Great care is taken to prevent a pathologic fracture. Thus in lesions of weight bearing bones the use of caliper splints is indicated until roentgenologic evidence of adequate bone regeneration is apparent. In some cases the slight degree of involvement permits a very brief period of restraint; in others some months are required to fill up the bone defect sufficiently to permit full function with safety. But during the interval attention is paid to restoring muscle tone and range of motion of neighboring joints, at the same time guarding against fracture.

Treatment of Malignant Giant Cell Tumor.—Whether one believes that malignant giant cell tumor is actually malignant from the beginning and merely simulates the benign variety, or that it represents a transformation from a benign process into a malignant one, does not alter the fact that once this condition is recognized, treatment by radical surgery alone offers hope of saving the life of the patient. For metastasis to the lungs is the usual termination.

It is our belief, however, that malignant transformation of a benign giant cell tumor, though an uncommon condition, is favored by chronicity and enhanced by incomplete surgical removal, particularly when combined with irradiation. For reasons not clearly understood, curettage and irradiation do not form a desirable combination in the treatment of giant cell tumor.

Though we have seen malignant degeneration follow treatment by surgery alone and by irradiation alone, it occurred more often where a combination of these methods was employed. There is some evidence, therefore, to suggest that irradiation is a factor in the occasional transformation of these benign tumors into definitely malignant ones. The application of radium into a bone cavity is mentioned only to be condemned. We believe that any giant cell tumor, that has not been successfully treated, is a potential source of danger of malignant transformation.

Age of the patient has been a factor to which too little attention has been paid. We find that in patients in the late thirties and early forties the giant cell tumor runs a more aggressive course, requires a more thorough extirpation by curettage, tends to respond less consistently to irradiation, and may become malignant. This is due no doubt to the decline in reparative power of cortical bone after the age of 20. The prognosis is therefore more uncertain in these older patients.

SUMMARY.—Our experience with both the surgical and the roentgen-

ologic treatment of giant cell tumor is based on a study of 90 cases at the Memorial Hospital, the majority of which were treated by irradiation, and in addition, a considerable number of cases treated at the Hospital for Ruptured and Crippled, Bellevue Hospital and Lincoln Hospital. In brief, we consider that the treatment of giant cell tumor of bone is neither wholly surgical nor roentgenologic. Tumors occurring in the spine, pelvis and other inaccessible locations are best treated by irradiation. Tumors in the upper end of the femur should be approached surgically with caution. Irradiation is often to be preferred because of the technical difficulties of curettage in this location. Tumors in the fibula, ulna, ribs and metatarsals may be resected, if extensive. Otherwise they yield to curettage. In advanced cases resection and subsequent restoration of destroyed area by bone graft may be required. Tumors in other long bones are suitable for curettage. Especially so are those in the lower femur and upper tibia. Complete destruction by the tumor of the entire extremity of a long bone is generally a serious contraindication to curettage. Amputation should be reserved (a) for cases showing unquestioned evidence of malignant transformation, or (b) for cases so far advanced that conservative measures are obviously inadvisable, and finally (c) in the lower extremity where, after surgery or irradiation, the result is a limb definitely inferior functionally to an artificial one.

Recurrences after surgical treatment are usually due to imperfectly performed or poorly chosen procedures. Attention is seldom called to the failures following irradiation therapy. Such failures, however, are not uncommon. Serious late sequelae following irradiation exist, and their management is difficult and often unsatisfactory. Surgery is preferred for giant cell tumors in accessible locations because the results are more predictable, attained more rapidly and with better final function; because errors in diagnosis are avoided by providing the pathologist with all the tumor tissue; because undesirable irradiation changes in the soft parts and the adjacent joint are avoided. Promiscuous cutting into these tumors is strongly condemned. The entire tumor bearing area should be removed if any operation is done.

Pre- or postoperative irradiation seems to us to be of questionable value, and we feel it may be hazardous. It seems far better to decide upon the use of either surgery alone or irradiation alone, rather than to combine the two methods.

REFERENCE

¹ Coley, B. L., and Sharp, G. S.: Pathological Fractures in Primary Bone Tumors of the Extremities. *Am. Jour. Surg.*, vol. 9, No. 2, pp. 251-263, August, 1930.

DISCUSSION.—DR. GEORGE E. BENNETT (Baltimore, Md.).—Giant cell tumor of the patella is one condition that can be treated with accuracy. If the tumor is a small one, it may be cured by curettage, but one should not hesitate to remove the patella after curettement in instances of large tumors or early recurrences as the end-result of such an operation is most satis-

factory. Murphy, in 1907, excised the patella and performed a plastic reconstruction with fascia lata, connecting the quadriceps and patella tendons. This operation, with its many modifications, gives one about 80 per cent of normal function in a knee joint.

DR. WILLIAM B. COLEY (New York).—Dr. Bradley Coley has, I believe, presented a very timely and excellent plea for the surgical treatment of giant cell tumors of the long bones. There has been a growing tendency during the last 15 years to substitute irradiation for surgery in the treatment of these tumors. Regaud, of France, has long been an enthusiastic advocate of irradiation, and in a paper published by La Charité on the results obtained in Regaud's clinic at the Radium Institute, 100 per cent success is claimed. However, an analysis of the 14 cases reported by La Charité shows that 12 were giant cell tumors of the jaw, one of the spine, and only one of a long bone, the upper end of the humerus. Unfortunately, in the latter, irradiation was used in conjunction with resection. Therefore this series offers no help in trying to determine the value of irradiation in the treatment of giant cell tumors of the long bones.

The tendency toward irradiation was greatly increased in 1931, following a discussion of the treatment of giant cell tumors at the annual meeting of the American Roentgen Ray Society in Atlantic City. At that time the question was raised whether surgery should ever be employed, and in reply one of our most distinguished pathologists stated most emphatically that the surgeon should never be called upon to treat a giant cell tumor. He added: "I have seen so many bad results from recurrence, malignant transformation, infection of all types, acute and chronic, resulting in amputation, that I have no longer any room to file these cases in our museum."

That there have been some bad results following the surgical treatment of giant cell tumors no one can deny; but the main point to be considered is the frequency of these results and when they occurred. A careful survey will show that most of the bad results occurred two decades ago before the use of Dakin's fluid and at a time when the technic of curettage had been but little developed. With improvement of the latter, the bad results from surgery became fewer and fewer until during the last decade they have been practically eliminated in the hands of surgeons who have had a wide experience in dealing with these tumors. The most important step in the improved technic, in my opinion, is closure of the wound without packing or drainage after curettage and chemical cauterization. This method was introduced by Dr. Bradley L. Coley at the Memorial Hospital about ten years ago, and so far he has not had a single failure to secure primary union.

The only bad result following surgical treatment of giant cell tumor at the Memorial Hospital occurred in a case of my own, 20 years ago: a very large, rapidly growing tumor of the fibula in which a diagnosis of malignant tumor had been made from the clinical and roentgenologic evidence. A complete resection of the fibula was performed by Dr. J. P. Hugué and myself. Not content with this, I very unwisely decided to have the large wound fulgurated with the Keating-Hart machine which had been recently brought over from Paris. The charred muscle offered a perfect soil for infection; three days later gas gangrene developed, and I had to perform an emergency amputation to save the patient's life. He made a good recovery and was well when last traced, ten years later. In this case the tumor was so extensive that most surgeons would have amputated in the first place.

In my earlier series, treated more than 20 years ago, in only three

cases was amputation necessary for an infected sinus following curettage; in two of these, the curettage had been done by another surgeon before the patient came to me. There is not a single case of sinus formation or infection following surgical treatment in the entire series treated by Dr. Bradley Coley and myself at the Memorial Hospital during the past 18 years.

The bad results following irradiation in the treatment of giant cell tumors are rarely mentioned and yet I believe they are more numerous and far more serious than the bad results following surgical treatment, even the surgery of a decade ago. Among those that I have personally observed are: severe burns causing prolonged disability and later intractable ulcers, which fail to heal and require amputation. In one case, a giant cell tumor of the upper end of the femur treated by irradiation in 1931, a very large burn developed which failed to heal after 18 plastic operations; the patient is now in a hopeless condition from ulceration and recurrence of the tumor. Again, in some instances irradiation has rendered the bones so brittle that fractures have resulted from slight strains, and the slow union of these fractures has meant prolonged disability. In two cases I have observed osteomyelitis develop later. In one case, a sarcoma of the upper end of the tibia which was regarded as cured by irradiation, osteomyelitis developed three years later, necessitating amputation. The other case, a giant cell tumor of the lower end of the femur, was frequently cited as one of the most brilliant cures of irradiation (180,000 mc.h. of radium had been applied in 1922 over a period of one year). Seven and one-half years later an extensive ulcer developed requiring prolonged hospitalization; eight and one-half years later osteomyelitis developed, which failed to respond to an extensive operation, and an amputation had to be performed the following year.

In my opinion there is greater danger of pathologic fracture developing after irradiation than after surgery. Our series shows that in 32 cases treated by irradiation, without biopsy, pathologic fracture occurred in nine; and in 22 cases treated by irradiation after biopsy or curettage, pathologic fracture occurred in nine also. While some of the bad results from irradiation occurred in the earlier years (1921, 1922, 1923), there has been little change in their relative frequency, some of the worst having occurred in the last five years. Phemister, of Chicago, has pointed out the unfavorable results of irradiation in the treatment of giant cell tumors of the femur, and our experience at the Memorial Hospital would seem to support this view. Of a group of 25 femur cases, 13 were treated by irradiation without biopsy with bad results in eight; and 12 were treated by irradiation after biopsy or curettage with bad results in four cases.

According to Bloodgood: "The greatest danger from irradiation is to persist in it too long, especially if the bone lesion is resectable, or to produce a deep-seated myositis which destroys the function of limb and makes amputation an operation of necessity. I have specimens of three limbs in the laboratory in which a bone was the seat of a benign cyst or osteitis fibrosa, and prolonged deep roentgen therapy had so destroyed the soft parts or necrosed the bone that amputation was made necessary. There are, in addition, five examples of giant cell tumors in which the introduction of radium into the bone shell, after curetting, was associated with an osteomyelitis which resulted ultimately in producing great deformity and loss of function, or making amputation imperative.

"These preventable results from irradiation have not all been in the hands of inexperienced radiotherapeutists. They have either been due to incorrect roentgenologic diagnosis which led to unnecessary irradiation for benign

tumors, or more frequently they were due to an attempt to cure malignant disease of bone irrespective of the results on the normal bone and soft parts. There is no necessity whatever for pushing irradiation treatment to this point."

I should like to make it clear that I am not opposed to the treatment of giant cell tumors by irradiation; in fact, one of the first cases reported in medical literature, in which a giant cell tumor was treated by the roentgen ray, was one of my own cases in which irradiation was used in conjunction with Coley's toxins. From the time the Bone Sarcoma Department was established at the Memorial Hospital, I agreed to permit all the service cases to be treated by primary irradiation. My own cases, and those at the Hospital for Ruptured and Crippled, I continued to treat by surgery. A comparison of these two groups, both numbering about 50 cases, in my opinion furnishes conclusive evidence of the superiority of surgical treatment for giant cell tumors of the long bones.

The greatest advantage of surgical treatment is that it furnishes one with a microscopic section of all parts of the tumor, and eliminates the error in diagnosis that occurs in at least one out of five cases treated by irradiation without biopsy—the method recommended by Ewing and Herendeen. Furthermore, it greatly lessens the period of disability, permitting the patient to return to work after a few weeks instead of the prolonged period (many months and sometimes two or three years) required for irradiation.

I agree with Ewing that surgery and irradiation should rarely if ever be combined in the treatment of giant cell tumors. While I have used irradiation in a few cases after curettage, the amount has always been very limited, not sufficient to seriously interfere with Nature's efforts to regenerate new bone to replace the portion destroyed by the tumor. Prolonged irradiation undoubtedly does lessen this process of repair.

Furthermore, and perhaps still more important, is the danger of prolonged irradiation after curettage transforming an originally benign giant cell tumor into a malignant sarcoma. In a recent paper on "Malignant Changes in the So-Called Benign Giant-cell Tumors," I reported 16 cases in which a benign giant cell tumor later became a malignant metastasizing sarcoma. Eight of these cases were treated by a combination of surgery (seven by curettage and one by open biopsy) and prolonged irradiation. This high proportion suggests a very strong probability that prolonged irradiation after curettage markedly increases the tendency to malignant transformation.

The Place of Coley's Toxins in the Treatment of Giant Cell Tumors.—The fact that giant cell tumors are so highly sensitive to Coley's toxins—far advanced inoperable tumors have disappeared under toxin treatment alone, and the patients have remained permanently well—makes it impossible to ignore the value of the toxins in any discussion of the treatment of giant cell tumors. On the other hand, I do not advocate the toxins as the method of choice in the treatment of operable giant cell tumors of the long bones, for the same reasons that I do not advocate irradiation. These are: (1) The impossibility of making a positive diagnosis of benign giant cell tumor from the clinical and roentgenologic evidence alone in at least one case out of five; and when the error is discovered it is usually too late to save the life of the patient by amputation; and (2) the greater time required to effect a cure compared with that required for surgical treatment. There remains, however, a very important field for the use of the toxins in giant cell sarcoma, and that is: (1) as a postoperative measure for one or two months after

curettage in the hope of lessening the number of recurrences. The latter occurred in 30 per cent of Bloodgood's series treated by surgery alone, and in 10 per cent of our own series treated by surgery and toxins; and (2) as the method of choice in the treatment of inoperable giant cell tumors, alone or in combination with irradiation.

DR. BRADLEY L. COLEY (closing).—The opinions expressed in the paper are those of my associate, Dr. Norman L. Higinbotham, and myself. We fully realize that there is room for a difference of opinion as to whether benign giant cell tumor of bone is better treated by irradiation or by surgery. From personal correspondence with both bone surgeons and roentgenologists we are led to believe that surgeons in general prefer surgical treatment for accessible lesions and irradiation for inaccessible ones, whereas roentgenologists tend to select irradiation for most cases regardless of location. Surgeons throughout the country hold surprisingly similar views as to the indications for irradiation or surgical treatment. Exceptions exist, however, and we should not, I believe, consider that the subject is a closed one. I would particularly emphasize our conviction that irradiation or surgery should be employed in a given case without mixing the two modalities, and further that preoperative irradiation is even more hazardous than postoperative irradiation. The interstitial use of radium or the introduction of radium capsules or tubes into a giant cell tumor that has been operated upon is unquestionably a hazardous procedure.

Two cases, to our knowledge, thus treated terminated as malignant giant cell tumors and caused the death of the patients, despite the fact that the original sections were regarded by the pathologists and the Bone Sarcoma Registry Committee of the American College of Surgeons as showing benign giant cell tumor.

I was interested in Doctor Bennett's report of the removal of a patella for giant cell tumor. This procedure seems wholly justified, although I have not as yet encountered a case occurring in this bone. Total removal of the patella was done in a case of synovionoma of the knee, however, and we were gratified at the excellent function of the knee joint which resulted.

SOME OF THE HAZARDS OF IRRADIATION

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IN THE vast literature on treatment by roentgen rays and radium, it is very noticeable that with comparatively few exceptions little, if any, emphasis has been laid on the untoward effects which frequently follow irradiation. As a matter of fact, in many of the articles such dangers are seldom even mentioned.

In several papers dealing with burns caused by roentgen rays or radium published during the last 15 years, I have endeavored to impress on those using these powerful agents for therapeutic purposes that there are certain very definite dangers to the patient unless the greatest care is exercised. Recently, however, a number of excellent reports have appeared which have really given facts that should be generally known instead of minimizing the untoward effects of irradiation, as seemed to be the unwritten law when writing on this subject.

In an excellent monograph published in 1934 by Colwell and Russ, chapters are given on the untoward results of irradiation in the skin, respiratory tract, circulatory system, alimentary tract, generative system, urinary tract, nervous system, eye, ear, bone, cartilage, muscle, connective tissue, adrenals, thyroid, thymus, mammary gland, radiation sickness, *etc.* These chapter headings will give an idea to those who are uninformed of the extent and wide distribution of the damage, which may be and has been done.

Inasmuch as there are still many who do not seem to realize the hazards of irradiation, I feel that it may not be amiss to again stress the importance of these dangers, and to reiterate that both radium and roentgen rays should be used for therapeutic purposes only by experts, and then with the utmost caution. In my work in reconstructive surgery, there have come under my care through the years a large number of patients who have had lesions which followed irradiation, which had been given for one cause or another. I have no personal knowledge of the technical application of roentgen rays or radium, but my experience with these agents has been entirely confined to the care of patients with lesions which have been caused by them.

No one can dispute the great value of roentgen rays and radium when applied for therapeutic purposes in suitable cases by those competent to use them, but the fact should be emphasized that frequently burns or other destructive tissue changes result, which in many instances are far more serious than the original lesion.

The enthusiasm of dermatologists and others who use radium and roentgen rays therapeutically is proverbial, and they regard irradiation as a panacea. The average user of radium and roentgen rays treats every growth, both

malignant and benign, with one of these agents, or with one and if this one is not effective, then with the other. It should be borne in mind that in many of these cases, a simple surgical excision is the method of choice, and if this method is used in suitable cases, a cure will be accomplished and the tissue changes which may be caused by irradiation can be avoided. Another fact which is often overlooked by the ray therapist is that some malignant growths are not ray sensitive and that instead of being destroyed, they are apparently stimulated in their growth by irradiation.

I am told by experts in roentgen therapy that, although the technic is constantly being improved, there is no excuse at the present time for a serious burn, if all the modern methods of dose measuring and machine calibration are properly carried out. When we add to this the other forms of protection for the patient and the operator now available, undesired tissue changes should become less and less frequent. However, I can still reiterate the statement made several years ago that I see more patients with ray changes each year. This increase in the number of ray burns is probably due to the fact that a larger group of patients are being irradiated than ever before.

I will consider briefly some of the untoward effects of irradiation and hope that the recital of these disasters may induce those who use these agents to be more careful in the application as well as in the selection of suitable cases for irradiation. My own experiences with these undesired effects have been principally confined to a large number of burns, which have been on every part of the body and to retardations of development. Many patients treated with roentgen rays or radium sooner or later after the acute reaction has subsided show the local characteristic signs of over irradiation: atrophy and dryness of the skin, loss of hair, pigmentation and telangiectasis, atrophy of the subcutaneous tissue, thickening and cracking of skin and nails, keratosis, ulceration and possible ultimate malignant degeneration. In the deeper tissues, fibrosis or destruction of muscles, necrosis of bone and cartilage, *etc.*

Most of the burns seen today are the result of the therapeutic use of roentgen rays or radium in dermatologic or other clinical conditions. Some follow the prolonged use of the roentgenoscope; some are due to over exposures by unskilled operators who often burn themselves as well as their patients; and some occur in spite of most careful exposures by skilled roentgen and radium therapists. There is also a fairly large group which follow depilatory treatment in beauty parlors.

Owing to the development of adequate protection for the operator, we seldom encounter serious ray changes on the hands of the modern trained roentgenologist, although we still see, now and then, on the hands of the pioneers in roentgenology and radiology, the blighting effect of multiple exposures to which they were subjected before the importance of protection was realized and real protection was available.

All degrees of burns may be produced from simple erythema, which follows the majority of treatments, to destruction of the whole thickness of the skin and varying depths of the underlying tissues. These burns may become

apparent very shortly after the treatment is given, but it is often found in the serious burns that the extent of the injury does not become apparent for months or even years after the treatments have been given. The reason for this long period of latency is well explained by Matas, who says, "The underlying pathology of these long delayed and necrogenic x-ray burns is a progressive proliferative endarteritis which obliterates the arterioles of the derm and subdermal connective tissue, leading to a gradual but fatal ischemia and nutritional disturbances in the radiated field." The same progressive proliferative endarteritis is found in delayed radium burns, and, to my mind, there is no other logical explanation for the delay in the appearance of tissue destruction in these ray burns.

Many of the burns which are referred to me are of long duration and have been treated by every conceivable local application. In many instances, roentgen ray burns have been treated with radium and radium burns treated with roentgen rays and various other rays. I cannot see the logic used in employing other destructive rays to restore tissue already completely changed by the original ray burn. My experience has been that when deep roentgen ray burns of long standing are treated with radium the condition is always made worse and vice versa.

When a deep burn has become definitely established, and local methods have been tried for a reasonable time without success, excision, with tissue shifting, is the only method which gives permanent relief from pain and which assures healing of the lesions as well as elimination of the danger of subsequent malignant degeneration. If the burn is small, it may be excised completely and the skin closed, or it may be removed by gradual partial excision.

Shortly after the discovery of roentgen rays, it was observed that living cells and growing tissues were markedly affected if exposed to these rays, and since that time considerable clinical and experimental investigation has been carried out along these lines. For years, I have observed that there is distinct retardation of the normal development of underlying bony structures in young children, in cases where new growths such as hemangiomata have been treated by irradiation, or, in other words, where the treatment has been given during the growing period. The retardation of the development of soft parts is also very evident in certain instances. I will outline an illustrative case.

When two or three months old, an infant with a hemangioma about the size of a five cent piece on the left side of the forehead was treated a number of times with radium. I first saw the child when it was two years old, and at that time the bony structure of the left half of the forehead was markedly undeveloped. There were definite ray changes of the soft parts, which in time will probably develop into a delayed burn. It is very doubtful whether this deformity caused by growth arrest will ever be naturally overcome, but it may be possible, when general development is complete, to fill out the retarded area by some plastic method. It was impossible to say at the time the patient

was seen whether there had been any damage done to the brain under this retarded area.

That the brain may be injured has been shown by several authors, and Markiewicz has recently reported a death with late roentgen lesions of the brain following roentgen ray radiation.

Another case of retarded development is that of a child who when three months old was treated several times with radium for hemangioma of the lower lip. She came under my care when 14 years old, after the completion of orthodontic measures. The lower lip was very small and thin, and was entirely composed of tissues which showed typical ray changes, both on the skin surface and inside the mouth. In addition, there was marked retardation of growth of the bone of the chin. Building out the contour of the chin and reconstruction of the lower lip was necessary in this case.

I have quite frequently seen the development of mammary glands in growing girls permanently arrested by irradiation used in treating thickened scars in the neighborhood of the breast. Localized retardation of development in growing children may occur in any region, or in any gland which is subjected to irradiation.

In a very interesting experimental study by Brooks and Hillstrom on the effect of roentgen rays on bone growth and bone regeneration, they found among other things that there was marked inhibition in the growth of bones exposed to a single massive dose of roentgen rays, and that the inhibition occurs only in the bone which is in the field of exposure.

In another group of experiments on young rabbits, they found that all animals receiving 40 per cent or more of the skin erythema dose showed definite inhibition of bone growth. Increased amount of irradiation always increased the amount of retardation. They found also that the total quantity of irradiation received always produced less inhibition of growth the larger number of times the dose was divided, or the longer the interval between the doses. Many more interesting facts were brought out in this paper, but the above will be sufficient for our purpose.

Facts such as these are either not known by many roentgen and radio-therapists, or if they are, are frequently ignored. My own feeling is that parents should be told of the possibility of such disasters, as retardation of growth as well as of ray burns, before irradiation is begun on young children. These untoward results may not be apparent for some time and the patient may never be aware of the primary cause of the growth arrest.

Much has been accomplished by deep roentgen ray therapy. Some years ago when this method of applying roentgen ray was in its infancy, I pointed out that it would be only a matter of time before burns of the overlying tissues and other disastrous deep tissue changes would develop in certain cases.

Some of the unfortunate end-results of deep therapy are now being reported in current journals, and it may be interesting to mention a few of them.

Only recently, Elliott and Jenkinson reported a death due to multiple

ulcerations of the stomach and small intestines following deep roentgen ray therapy applied to the abdominal region. I am convinced that serious consequences from deep roentgen ray therapy will be reported more and more frequently from now on, as more of this treatment is constantly being given and it is inevitable that bad end-results, directly due to tissue changes caused by the irradiation, will gradually come to light. In many of these patients treated by deep therapy, there are also marked changes of the superficial tissues, but these are seldom considered by the therapist of sufficient importance to mention, although they may give the patient continuous serious discomfort, and may also eventually undergo malignant degeneration.

The radium packs now being used for deep therapy must also be handled with the greatest care. I have seen severe burns follow the use of these packs, and have no doubt that in spite of all possible protection, deep tissue changes, which will have grave consequences for the patient, will in time also develop, as they have following deep roentgen therapy. Personally, I can see little advantage in any cure which while disposing of the original lesion leaves the patient in constant permanent torment.

In a recent paper, Huhner reports several cases where in spite of the greatest care in protecting the testicles, roentgen rays used in treating some dermatologic conditions of the thighs or perineum by experienced dermatologists interfered with the spermatogenic function of the testicle or destroyed it entirely. He believes that some testicles are very sensitive to the action of roentgen rays and that doses which are ordinarily considered harmless, in spite of what seems to be adequate protection, may cause sterility. The sterility of both males and females, who are constantly being exposed to roentgen rays in the course of their professional work, is well known.

Douglas Quick has shown that the use of radium in the treatment of vernal catarrh may be followed in some instances by serious consequences. Damage to the lens, as well as damage to the eyelashes, scarring and thickening of the lids and conjunctivitis have all been noted. These hazards should be thought of when radium or roentgen rays are used for therapeutic purposes on lesions in the region of the eye. Although these facts are of common knowledge, it is seldom that there is any hesitation on the part of the roentgen- and radiotherapist in using irradiation on lesions of the eyelids and adjacent soft tissues.

I have under my care at the present time a patient, 37 years old, who had been treated with roentgen rays for eczema of the face, off and on over a period of eight years, and was severely burned. In addition to several areas of beginning malignant degeneration in the burned area, one of which was on the eyelid, bilateral cataracts are developing, which undoubtedly have been caused by the ray treatment.

Nelson and Hirsch report a death due to late roentgen radiation necrosis of the larynx, which followed treatment of a lymph node of the neck. They review the literature and show that the injurious effect of irradiation on the larynx has been recognized for some time. In spite of this knowledge, this

therapy has been and is being used for the treatment of a varied group of affections of the throat and neck besides cancer, in what seems to me to be a haphazard way. The authors warn roentgen therapists of the dangers of damage to the larynx, which is apparently hypersensitive to irradiation, when irradiation is used in the treatment of carcinoma or other diseases of the neck, and stress the serious nature of such injuries to the patient. I have had under my care a number of extensive deep burns of the neck following irradiation of the thyroid, and in some of these a portion of the trachea had been destroyed.

I recently saw a woman upon whom a radical breast amputation had been done several years ago, following which postoperative roentgen radiation was given. This irradiation has caused almost complete cessation of thyroid function, and this cessation is apparently permanent. Finzi and others have reported serious changes in the lung following the treatment of carcinoma of the breast by roentgen rays.

Little is ever said before treatment is begun of the tremendous prostration, headache, nausea and vomiting, general discomfort, loss of appetite and depression, accompanied in many instances by blood changes, which often occur following both superficial and deep irradiation. These reactions are occasionally so severe that days may elapse before recuperation is complete, and there are cases reported where the outcome was fatal.

COMMENTS.—One has only to take care of burns and other tissue changes caused by irradiation to realize their great importance to the patient, as well as to those who produce these burns. Severe immediate and delayed burns sometime follow single exposures but are more frequently caused by multiple exposures. The susceptibility of the skin of certain individuals to irradiation must be taken into consideration.

The tendency to malignant degeneration in chronic roentgen ray or radium burns is interesting and important, and I see each year more patients in whom this degeneration has taken place. It has been noted that malignancy rarely develops in lesions resulting from a single massive dose or a few exposures at short intervals. It occurs more frequently in burns which are the result of many exposures over a long period of time.

When I read in the press that large and inexhaustible deposits of radium producing ore are reported to have been discovered, and that if this report is true, radium will be so cheap that it can be in the hands of most physicians, it makes me wonder whether it would be such a blessing after all, as I firmly believe that if this were ever possible, the harm done to patients by the ill-advised use of radium in incompetent hands would be many times greater than any benefit that could be obtained. The only reason, in my opinion, why there is any limit to the number of burns caused by radium is that it is still too expensive for general use.

At the present time, I understand that there are certain commercial companies who rent out radium itself or radium element (radon) to any member of the medical profession, who is able to pay the fee required. Doubtless this

dangerous agent is thus often put into the hands of well meaning but inexperienced persons, who, not realizing the danger, feel that if someone else can get results with radium, there is no reason why they cannot also. The ability to secure radium for therapeutic use is not confined alone to those renting the material, but sometimes radium can be borrowed from institutions and doctors or technicians in these institutions, who are without experience, can use it.

As far as I am able to ascertain, there is no control of the sale of roentgen ray machines or of radium in the United States or any other country. Any individual can purchase either of these highly dangerous agents if the money is available, regardless of his fitness to use them.

Much trouble would be avoided if the possible dangers, as well as the anticipated good results of irradiation, were explained to prospective patients, instead of subjecting them to this treatment without their being aware that danger exists.

I feel strongly that all radium and all roentgen ray apparatus used for therapeutic purposes, both superficial and deep, should be so controlled that these agents could be in the hands only of those thoroughly competent and trained to use them. I further believe that if the extent of the damage done by these two agents, as at present used, were realized, drastic regulations would follow. The sooner it does, the better for all concerned.

The instances of the hazards of irradiation used for therapeutic purposes mentioned in the preceding paragraphs, as you can realize, only touch the surface of such happenings. However, my hope is that they will be sufficient to make those who use these agents "stop, look, and listen."

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DISCUSSION.—DR. JOHN A. MOORE (Houston, Tex.).—I think it is very fortunate indeed that Doctor Davis has called attention at this time to the dangers of roentgen rays and radium when used by persons who are uninformed and inexperienced in their use. I do not doubt that many of those here have seen ill effects in many cases from these agents. I regard these two agents as two of the most valuable that we have had given to us by science, when properly used. We are reminded also that there are many other agents that are being misused. In the Presidential Address of Doctor Payne he called attention to the situation we are facing constantly with ill trained surgeons, or with those without experience and training, who attempt to do things they are not fitted to do.

Hearing these papers, and hearing many discussions of other issues, I am reminded of a group of men who were talking with Will Rogers, when the Mayor came from the outer part of the gathering in an attempt to get Rogers to go to the platform and be seated. The Mayor said in a loud voice, to attract his attention, "I am Mayor Holcamp," and Will Rogers replied in his own way, "What are you going to do about it?" Unless someone goes preaching in the wilderness about these matters nothing will ever be done about it, but how many of us in the communities in which we reside are raising our voices in the correction of these various things? It seems to me that should be part of our attempt in the correction of these evils. I do not know what to propose, but as was intimated in a discussion yesterday, if this surgical group, or any group that is well trained, does not tackle these things in a corrective way, then I think our meetings are somewhat in vain, for it is only in such correction that we may ever hope to overcome these evils. Doctor Davis has called attention to the fact that the danger has increased now that radium has become so cheap, and that it is being rented to persons who have had no instruction in its use for as little as sixty dollars a month. For this sum you can rent 100 mg. of radium, and it is placed in hands from which much danger is sure to come.

DR. VILRAY P. BLAIR (St. Louis, Mo.).—Usually after Doctor Davis talks I could limit my comments to two words, "Me too." It would certainly be a great help if the use of roentgen ray machines and radium could be controlled as suggested, but we have tried prohibition! Of course, this paper of Doctor Davis's, and others like it, will gradually influence those who may influence others, but I think the direct attack at present is hopeless.

We have ourselves demonstrated the possibility of deep radiation damage in efforts to treat absolutely inoperable carcinomata by large doses, put in with the skin flaps retracted. Whether that is a good thing or not we are not yet sure, but we do know we have damaged the deeper structures by taking away the control of the skin. One good point is that these patients get little of the sickness they get when the dosage is put in through the skin.

There is no question that cancer is prone to develop later in skin damaged by radiation, but sometimes it is the original growth for which the roentgen therapy was given, some of the cells of which have remained entangled in the scar. I have seen that demonstrated 27 years after the control of a breast carcinoma of the glandular type. It recurred as a little nodule and we then removed that nodule and a large part of the scar, immediately covering the raw area with a free graft, almost immediately little nodules occurred all over the area from which we had removed the scar tissue.

DR. JOE V. MEIGS (Boston, Mass.).—Being in charge of radium administration for carcinoma of the cervix at the Massachusetts General Hospital and at the Massachusetts State Cancer Hospital at Pondville, I am greatly

interested in Doctor Davis's report, which I think is an extremely important one. The use of radium is not difficult to those who know nothing about it, but is most difficult, however, to those who do know something about it. I have seen over 1,000 cases of carcinoma of the cervix, and feel that I know something about what can happen to patients who have been treated with radium. There have been a number of cases of carcinoma of the cervix where the use of radium has produced a large fistula between the bladder and vagina. There are other patients who have died of kidney infection, in whom no evidence of carcinoma of the cervix could be found at autopsy, but in whom tremendous fibroses of the pelvis were present. I have seen one case recently where radium was given for uterine bleeding and within two years a peculiar carcinoma of the bladder occurred which appeared to be on the site of a radium change. Another patient treated by Doctor Dudley of Chicago 13 years ago for abnormal bleeding had a peculiar discharge for many years thereafter. She was a patient of Dr. W. P. Graves's for several years and came to me recently, Doctor Graves having died, and was found to have an unusual carcinoma of the body of the uterus with a metastasis to an ovary.

I would like to sound a warning to everyone to be careful and thoughtful in using radium, for disasters can occur and they are extremely unpleasant.

TUMORS OF THE KIDNEY

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TUMORS of the kidney may be malignant or benign. With the exception of cystic tumors, I agree with Bugbee and McKay,¹ who state that every tumor of the kidney should be considered malignant and treated as such. They may involve the parenchyma, the pelvis or both.

The classification of tumors of the kidney is a much mooted question. I shall not bore you with the various pros and cons of this controversy further than to state that I believe in the Grawitz theory of the adrenal rest origin of hypernephroma, that they vary in the grade of malignancy and that carcinoma and sarcoma both occur independently of hypernephroma and are probably due to intrinsic causes, *e.g.*, inflammation, toxemia, *etc.*, and to extrinsic causes, *e.g.*, trauma, stone, *etc.* The classification of tumors of the kidney by Bugbee and McKay with slight additions is as follows:

TUMORS OF INFANCY AND CHILDHOOD

Embryonic in Origin

Wilms' tumor (malignant)

TUMORS OF THE ADULT

Malignant	{	(1) Parenchymal tumors. Hypernephroma. Grawitz
		(2) Adenocarcinoma
		(3) Papillary carcinoma
		(4) Sarcoma

Benign	{	(1) Adenoma	(4) Angioma
		(2) Leiomyoma	(5) Lipoma
		(3) Fibroma	(6) Lipomatosis
		(7) Solitary cysts	

PELVIC TUMORS

- (1) Benign? papilloma
- (2) Malignant papilloma
- (3) Squamous cell carcinoma

TUMORS OF THE CAPSULE

Lipoma

ETIOLOGY.—The cause of tumors of the kidney, like those in other portions of the body, is still purely conjectural. As previously stated, the Grawitz theory probably accounts for hypernephroma, while carcinoma and sarcoma are caused by trauma or irritation. Non-malignant tumors may be due to inflammation, toxemia or some metabolic disturbance. Reimann¹¹ divides hypernephroma into two types, typical and atypical. In the typical

type the cells are arranged in layers as in the cortex of the adrenal, while in the atypical the cells are irregular and not in layers. He states that the typical type is relatively benign while the atypical is definitely malignant. This, however, has not always been true in the cases seen by the author. The atypical, however, are more likely to be malignant, but many very malignant ones are of the typical type. Tumors of childhood are conceded to be of embryonic origin. It is true, too, that tumors having their origin in contiguous structures may invade and finally involve the entire kidney.

SYMPTOMS.—The great triad, hematuria, pain and tumor are the cardinal symptoms of tumor of the kidney. Unfortunately for diagnostic purposes, but fortunately for the patient, tumor is not always appreciable, for when it is palpable, it is usually in the late stage and the possibility of a cure is greatly diminished. Late symptoms, too, are anemia and loss of weight.

Symptomless hematuria is frequently the one and only sign of tumor of the kidney and it often requires the most thorough and painstaking urologic study to prove that a tumor is present. Sometimes small particles of tumor tissue may be voided in the urine, but this is a rare finding. Many other symptoms may occur in these cases that result from the tumor itself or from pressure or secondary infection, *e.g.*, there may be frequency, burning, tenesmus and nocturia, or the last may be present without the other three. Blockage of the ureter or a calix by pressure of the tumor or by blood clots, pus or a stone can cause renal colic. Dyspnea may be present and in some cases the blood pressure is low while in others it may be high. In the cases I have seen I do not feel that the tumor of the kidney played any large part in the production of high blood pressure. It is a fact, however, that toxemia, with resulting anemia and loss of weight, could easily account for a low blood pressure. This view coincides with that of Barney.² Fever, too, may be present but is due to infection, back pressure, absorption or metastases.

Varicocele is said to occur on the involved side. Although varicocele is of frequent occurrence in patients without tumor, I have never seen marked varicosities in a patient with a tumor of the kidney. George Smith⁸ makes this same observation, but states that in Dr. Robin Pearses' Clinic in Toronto he saw a tremendous varicocele in a patient with a large left renal tumor.

Most cases occur in men. In the 28 cases tabulated, 20 were in males and eight in females (Table I). Barney,² however, reports 43 cases in females and 41 in males. Kretschmer,³ in 1925, reported 40 males and 14 females and Foulds⁴ reporting from the Mayo Clinic in 1923 found 72.42 per cent in males. George Smith and A. B. Shoemaker⁸ report 62 cases from the Massachusetts General Hospital with 43 in males and 19 in females.

In childhood there are few symptoms. In fact, the condition is usually discovered only after the mother notices the abdomen increasing in size or a mass in the abdomen or loin. Blood and frequently pus cells will be found in the urine, although the passage of blood stained urine is rare. I would

TABLE I
SYNOPSIS OF TWENTY-EIGHT TUMORS OF THE KIDNEY

Case No.	Sex	Age	Race	Date of operation	Duration of symptoms	Tumors	Hematuria	Pain	Symptoms	Metastases	Results	Kidney involved	Character of tumor	Treatment other than nephrectomy
1	M.	47	W.	6-11-34	1½ yrs.	Yes	Yes	Yes	Suppression of urine. Loss of wt. Anemia	Left femur. Path. fracture	Died, October, 1934	Left	Hypernephroma	
2	M.	67	W.	4- 3-35	6 mos.	Yes, very large	Yes	Yes	Loss of wt. Dysuria, nocturia, weakness, anemia	No	Living, October, 1935. Weak, cachectic	Right	Hypernephroma	
3	F.	45	W.	4- 6-34	1 yr., 4 mos.	No	Yes	Yes	Frequency, dysuria, anemia	No	Living	Right	Epidermoid carcinoma of ureter and kidney, primary in ureter	
4	M.	?	W.	12- 4-34	13 mos.	Yes, large, nodular	No	Yes	Loss of wt. Anemia	No	Living	Right	Sarcoma	
5	F.	47	W.	No operation	2 yrs.	Yes	Yes	Yes	Anemia and loss of wt.	Left cervical nodes	Living	Left	Hypernephroma	Deep x-ray, 1934
6	M.	50	W.	No operation	1 yr.	Yes	Yes	Yes	Loss of wt. Anemia, dysuria	Left cervical nodes	Died	Left	Hypernephroma	Deep x-ray
7	F.	62	W.	10- 1-34	6 wks.	Yes	No	Yes	Loss of wt. Gastro-intes. anemia	Peritoneum, mesocolon, greater omentum, liver	Died	Left	Adenocarcinoma	Deep x-ray
8	M.	52	W.	No operation	?	Yes	No	Yes	Cachectic, loss of appet. Loss of wt.	Lymph nodes, left axilla	Died	Left	?	Deep x-ray
9	F.	48	W.	No operation	6 mos.	Yes	Yes	Yes	Nausea. Loss of wt.	No	Living	Left	Hypernephroma	
10	F.	5	W.	April, 1935	5 mos.	Yes	Yes	No	Nausea, anemia, pain in abdomen	No	Died, 2 mos.	Left	Embryonic carcinoma	
11	M.	3	W.	No operation	2½ mos.	Yes, large	No	No	Nausea. Loss of appetite	No	?	Left	Embryonic (not operated)	

12	M.	50	W.	No operation	Neph. for yrs.	Yes	Yes	No	Suppression of urine. Anemia	No	Died	Right	Hypernephroma?
13	M.	53	W.	8-2-30	1 yr.	Yes	Yes	Yes	Digestive disturb. Loss of wt. Rigors and Fever	Ribs	Died 3 years	Left	Hypernephroma
14	M.	58	W.	12-29-30	3 yrs.	Yes	Yes	Yes	Digestive disturbance	No	Died, 6 mos.	Left	Hypernephroma
15	M.	41	W.	3-6-31	2 yrs.	Yes	Yes	Yes	No	No	Died, 1 yr.	Left	Hypernephroma
16	M.	2½	W.	9-14-33	3 mos.	Yes	No	No	Fever, gastro-intestinal	No	Died, 2 mos.	Left	Adenocarcinoma
17	M.	48	W.	8-25-34	4 yrs.	Yes	No	No	Digestive	No	?	Right	Hypernephroma
18	M.	46	W.	1-16-32	2 yrs.	Yes	No	Yes	Weakness, gastro-intestinal	No	?	Right	Hypernephroma
19	M.	56	W.	12-27-32	2 yrs.	No	Yes	Yes	Dysuria, had passed three stones last two years	No	Well, October, 1935	Right	Hypernephroma
20	F.	57	W.	4-16-32	3 mos.	No	No	Yes	Swelling of left thigh and leg	No	Died	Left	Adenocarcinoma
21	M.	58	W.	1-22-32	1 yr.	No	Yes, 6 wks.	No	Weakness, nocturia	No	?	Right	Hypernephroma
22	M.	7	W.	No operation	5 mos.	Yes	No	Yes	Frequency	Yes, lungs	Died	Left	Embryonic round and spindle cell sarcoma
23	M.	64	W.	1-21-32	3 wks.	No	Yes	No	Frequency, nocturia	No	Living and well	Right	Hypernephroma
24	M.	57	W.	6-14-33	3 yrs.	No	Yes	Yes	No	No	Living and well	Left	Hypernephroma
25	F.	59	W.	5-24-35	9 mos.	No	No	Yes	Frequency	No	Died, October, 1935	Left	Hypernephroma
26	M.	62	W.	7-31-34	6 mos.	No	Yes	Yes	Frequency and nocturia	No	Died, 1½ mos.	Left	Papillary adenocarcinoma of kidney pelvis
27	M.	45	W.	7-28-28	3 mos.	No	Yes	No	No	Yes, blad.	Living	Right	Papillary adenocarcinoma of renal pelvis
28	M.	45	W.	1930	3 mos.	Yes	Yes	Yes	Frequency, dysuria, fever and colic	Yes	Living	Left	Hypernephroma

therefore again stress the importance of the presence of pus and blood cells in the urine and urge you to insist upon a thorough urologic study to determine their source and cause.

As the tumor increases in size, pain and pressure symptoms such as ascites, edema of the external genitals and lower extremities and gastrointestinal upsets occur. Rapid loss of weight and anemia are later manifestations, the latter often enhanced by hemorrhage within the tumor and unless it ruptures into the pelvis or calices does not appear in the urine.

METASTASES.—Metastases may occur, even in the early stages, to the lungs, pleura, liver, ribs, skull, scapula, long bones, peritoneum, omentum, renal vein and vena cava, lymph nodes of the neck and axilla, nose, cerebellum and pancreas. Even when these have occurred in hypernephroma, nephrectomy, followed by deep roentgen ray therapy, may give the patient many years of useful life.

DIAGNOSIS.—The early diagnosis of kidney tumors is often very difficult, even with the present day refinements in cystoscopy and roentgenology. The P.S.P. test in some cases is of little value, for even if the tumor is large, enough healthy kidney tissue may be left so that there is little reduction in output. It should be made routinely, however, as it may, with other evidence, be the deciding factor in the diagnosis. Plain roentgenograms and pyclograms, both retrograde and intravenous, should be made and repeated in order to check our findings and eliminate blood clots and spasm of the pelvis and calices, as well as fecal masses and distortion due to pressure of other structures. I agree with George Gilbert Smith⁹ that intravenous urography is often unsatisfactory due to the diminished function in the involved kidney; though even when the function is good a satisfactory pyelogram may not be obtained. In children intravenous urography may be sufficient, but in many cases it does not indicate the functional capacity of the good kidney. I therefore advise retrograde as well as intravenous pyclograms; for cystoscopy can be done even in babies with the same degree of precision and with much less reaction than in the adult. I have performed cystoscopy and catheterization of the ureters of a girl two days old and a boy six weeks old.

TREATMENT.—All tumors of the kidney except the cystic types should be considered malignant or potentially so, hence nephrectomy should be done. When the tumor is very large and its removal would be too hazardous, pre-operative deep roentgen therapy, as suggested by Walters,⁶ and Bugbee and McKay¹ often results in such marked reduction in the size of the tumor as to render its removal much less difficult. It may also tend to prevent metastases by way of the lymphatics. Extraperitoneal removal is to be preferred and every precaution used to remove all malignant tissue and prevent contamination of the wound with tumor particles or infected material. It is exceedingly difficult in many cases to remove all the malignant tissue, for it is often found that the tumor has invaded the perirenal tissues by extension or by rupture of the capsule. If this has occurred or should the tumor

be ruptured during nephrectomy, flooding the wound with iodine followed by alcohol may prevent implants on the denuded areas. The perirenal fat should be completely removed. Transperitoneal nephrectomy is the operation of choice in the very large tumors that fail to reduce in size under deep roentgen therapy. The technic advocated by Wharton⁵ makes it a less formidable operation. Eisendrath and others advise preliminary ligation of the vascular pedicle transperitoneally, to be followed later by extraperitoneal nephrectomy. If the patient's condition is poor and deep roentgen therapy fails to reduce the size of the tumor, I think this is a very excellent procedure.

Should nephrectomy be performed in the presence of metastases? This is a question of selection of cases. It is sometimes true that the patient is so uncomfortable from intercurrent affections such as infection, renal colic, hemorrhage, *etc.*, that regardless of his condition something must be done. It is also true that even when metastases have occurred the removal of the kidney, followed by deep roentgen therapy to both the kidney area and the metastases, sometimes gives the patient many years of useful life and freedom from pain. Bumpus⁷ cites such a case with metastases in both lungs, living and well four years after nephrectomy. One of my own is similar to that of Bumpus. A man, aged 53, with an hypernephroma of the left kidney, had an intercurrent pyelonephritis and suffered frequent attacks of rigors, high fever and hemorrhages that could be controlled only by cystoscopy and the introduction of an indwelling catheter. The relief, however, was only temporary. There was roentgenologic evidence of metastases in the ribs. In view of the metastases we felt that nephrectomy would be useless, therefore advised deep roentgen therapy. As the attacks continued, the patient insisted that something be done. Nephrectomy was performed and later deep roentgen therapy was given. He made an excellent recovery from his operation, was free of symptoms for two years, but died of metastases in the lungs.

In tumors of the renal pelvis, the kidney, ureter and a section of the bladder about the ureteral orifice should be removed. If the patient's condition is too poor to permit this at one sitting, nephrectomy may be done and the ureter and its orifice removed later. Colston¹⁰ has suggested removing the ureter, severing it near the bladder then destroying the mucosa of the remaining ureter for 1 cm. about its orifice with the high frequency current. If this proves as satisfactory as removal of the entire ureter and its orifice, it will obviate the necessity of the more extensive operation.

Coley's toxins have been recommended for malignant tumors of the kidney. Coley¹² reports four cases, a Wilms' tumor, an adenocarcinoma, an hypernephroma and a round cell sarcoma apparently cured and well after 29, 6, 16 and 23 years, respectively. I have had no experience with Coley's toxins in the treatment of tumors of the kidney and have seen no reports of its use except that of Doctor Coley.

CONCLUSIONS

(1) All kidney tumors except cysts should be considered malignant and treated as such.

(2) Nephrectomy should be done when possible as it may give relief from pain and several years of life even in the presence of metastases.

(3) Deep roentgen therapy may reduce the size of the tumor and make an inoperable case an operable one.

(4) In tumors of the renal pelvis the ureter and a section of the bladder about its orifice should be removed, or the ureteral orifice and adjacent bladder mucosa may be destroyed with the high frequency current.

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DR. WILLIAM B. COLEY (New York, N. Y.).—Doctor Livermore has called attention to a case I originally reported before the American Urologic Society last winter, and I will give a few words of elucidation.

First, I wish to call attention to what you all appreciate, *i.e.*, the high malignancy of tumors of the kidney. The recent paper of Geschickter and Widenhorn on "Nephrogenic Tumors" (Am. Jour. Cancer, No. 4, December, 1934), showed almost 100 per cent mortality of kidney tumors in children and others as well; and the same was found to be true at the Presbyterian Hospital in Chicago on the service of Doctor Bevan. Of the four cases referred to by Doctor Livermore, only two were my own. It is important to know, however, that others, as well as myself, can get results with the toxins. It shows the two types of tumor in which I think Coley's toxins should be used by anyone who has to treat a tumor of the kidney.

In the cases that are inoperable, the toxins should be used as a prophylactic after operation. Two of the four cases referred to were inoperable. One of these was a woman aged 27, under the care of Dr. H. K. McDonald and Dr. A. S. Burns of Halifax, Nova Scotia. An exploratory operation revealed the lower pole of the kidney to be occupied by a large tumor which was adherent to a much larger growth anteriorly. A laparotomy was then performed disclosing a large retroperitoneal mass which it was impossible to remove. A section was removed and pronounced a round cell sarcoma by Dr. W. A. Lindsay. The patient was sent home to die. She had lost 40 pounds in weight. However, as a last resort it was decided to try Coley's toxins. The treatment was begun at once, and the patient showed immediate and rapid improvement, going on to a complete recovery. Fifteen years later, Doctor McDonald performed a hysterectomy for a fibroid tumor, at

which time he had an opportunity of examining the whole abdomen; there was no evidence whatever of the tumor of the kidney. She was well when last traced, 23 years later.

The second case treated by another surgeon was a woman aged 37, under the care of Mr. Arthur Connell, Professor of Surgery, University of Sheffield, England. An exploratory operation was performed, and a microscopic report of hypernephroma was made. The condition was inoperable. I advised the use of the toxins, which treatment was carried out by Mr. Connell. The patient made a complete recovery and was well 16 years later. This case was included in my report before the Third International Research Conference in Brussels in 1913.

The third case was a Wilms' tumor (adenosarcoma) in an infant aged 18 months. Dr. J. W. Perkins, of Kansas City, performed a nephrectomy for a large sarcoma of the kidney August 27, 1903. I advised using Coley's toxins as a prophylactic, and sent him a bottle that had been prepared by Dr. B. H. Buxton. The treatment was carried on for two years. This patient is in excellent health at the present time, more than 29 years later.

The last case was a male, aged 44, who was sent to me in December, 1928, by Dr. Charles G. Kerley, with a very large tumor of the kidney which had almost reached the inoperable stage. I referred him to Dr. Benjamin H. Barringer for a nephrectomy which it took two hours to perform. The patient was then given two exposures of high voltage roentgen therapy, after which the toxins were begun and carried out under my direction for three months by Dr. J. S. Chaffee, Sharon, Conn. This patient is still well at the present time, six years later.

If we can cure some inoperable malignant tumors of the kidney, and keep operable cases well for many years, with injections of Coley's toxins, I think the method is well worth trying.

ATRAUMATIC REMOVAL OF NEEDLE FROM HAND

UNDER FLUOROSCOPIC CONTROL

WILLIAM H. PRIOLEAU, M.D.

CHARLESTON, S. C.

THE difficulty of removing a needle from the hand often is not appreciated by those who have not attempted it. Accordingly it is frequently undertaken with inadequate facilities and by someone not sufficiently familiar with the surgical technic involved. As a result a common story is that a long search or several attempts have been necessary before the needle was located. The difficulty lies in the fact that during the operative procedure the needle moves quite readily among the ligaments of the hand, and thus the preoperative localization is of little help. The ligaments interfere with palpation and a bloody field makes recognition of the needle difficult, especially if it is discolored. Nerves and blood vessels are subject to injury, and irreparable damage may be done. The long search or the repeated attempts, with the resulting trauma, predispose to infection, which may cause death.

The technic about to be described was gradually developed following a conversation with Dr. B. H. Nichols, roentgenologist at the Cleveland Clinic. He advocated localization and fixation under fluoroscopic control followed by removal at open operation. In the proposed technic, the first principle is utilized but the second is fundamentally modified in that the necessity for the open operation has been practically circumvented. No claim to priority is made as this method is essentially an extension of the now generally accepted principle of localization and fixation under fluoroscopic control. However, a review of text-books and periodicals fails to show the technic here described.

While localization under the fluoroscope is generally accepted as being the only consistently satisfactory method, a number of technics for the extraction of the needle have been advocated. Carlos Santos,³ of Lisbon, has been particularly interested in this subject and described an ingenious instrument with which he engaged the needle under fluoroscopic control and extracted it. It seems to have worked most satisfactorily in his hands. However, the objections may be raised that the instrument is not generally available, that it requires an unnecessary amount of manipulation under the fluoroscope, and that its withdrawal is made possible only by its cutting some tissues blindly. A number of electric localizers have been devised, but they have been generally found to have a limited application. Head fluoroscopes planned to give the operator intermittent fluoroscopic and normal vision have proven impractical. At present the most satisfactory method

Fig. 1.



Fig. 3.



Fig. 2.

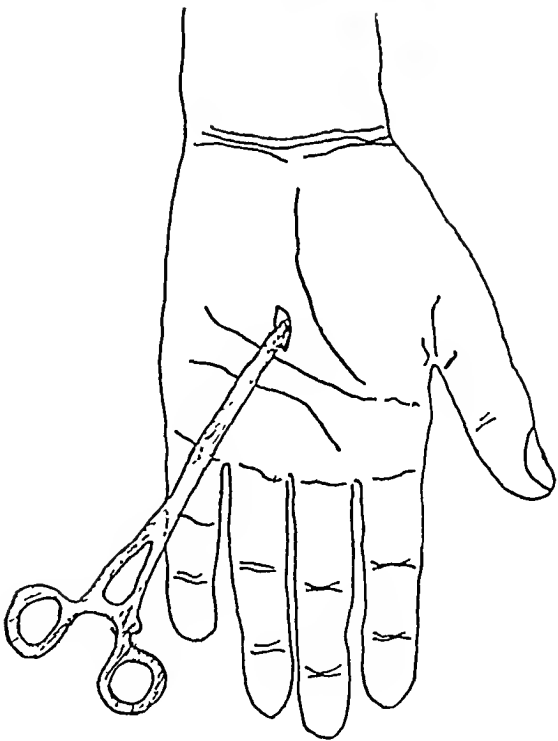


Fig. 4.

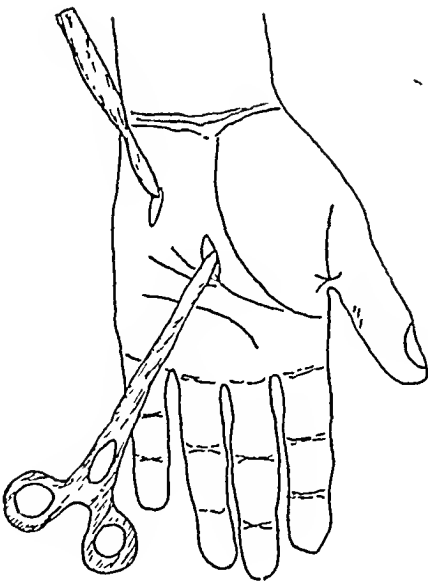


Fig. 1.—Roentgenogram of a needle in the hand.

Fig. 2.—Closed mosquito forceps in incision over needle.

Fig. 3.—Localization and grasping of the needle by mosquito forceps, under fluoroscopic control.

Fig. 4.—Second skin incision over the end of the needle, as determined by palpation.

used to any extent is localization and fixation under the fluoroscope followed by open operation.

The desideratum is to accomplish the removal without traumatizing the tissues, both on account of the danger of infection and of injury to important structures. This is done by localization and fixation under fluoroscopic control with removal by manipulation, of one end into a second skin incision. This reduces the trauma of operation to a negligible degree.

Operative Technic.—(1) After preliminary novocain infiltration, an incision 1 cm. in length is made through the skin over the needle, as located under the fluoroscope (Fig. 1). The point of a closed pair of mosquito forceps is inserted into the incision (Fig. 2).

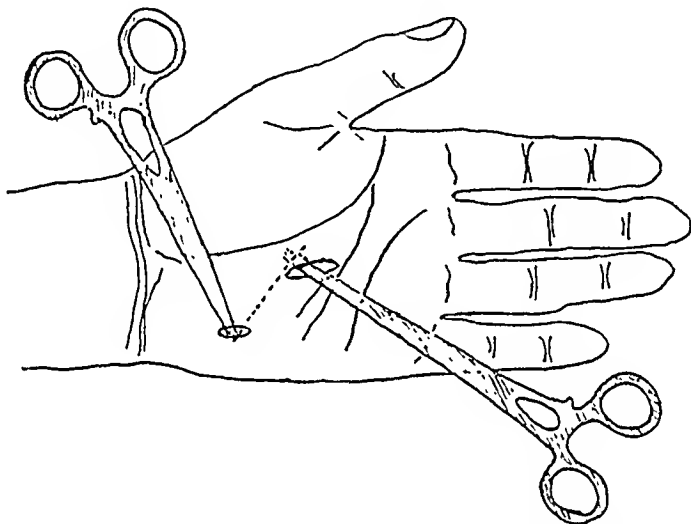


FIG. 5.—Needle being withdrawn through second incision.

(2) Under fluoroscopic control and by manipulation of the hand, the end of the closed forceps is advanced toward the needle. Once contact is established the forceps are opened slightly and made to grasp the needle, preferably near the middle (Fig. 3). The forceps are then securely locked, the fluoroscopic screen removed, and the light turned on.

(3) By manipulation of the forceps with one hand and gently pressing the surrounding skin with the index finger of the other hand, one end of the needle may be brought near the surface so that it can be palpated through the skin.

(4) Over the palpable end of the needle an incision $\frac{1}{2}$ cm. long is made through the skin (Fig. 4).

(5) By further manipulation of the forceps and the index finger, the end of the needle can be brought into view in the second incision.

(6) This end is grasped with a second pair of forceps (Fig. 5); the first is unlocked; and the needle is easily withdrawn.

(7) Sutures are unnecessary as the edges readily approximate; also it is better that there be some provision for drainage.

(8) A roentgenologic examination is made for record and to determine if any part of the needle remains.

As regards the patient, the foregoing procedure consists of two small skin incisions and a little blunt dissection. Trauma is reduced to a minimum and accordingly minimizes the danger of injury and infection.

The mobilization of the needle utilized in this procedure is made possible by the same factors which ordinarily hinder its localization. It might seem as if the needle should be extracted by the first forceps, but this is not the case as there should be no unnecessary manipulation of the forceps under the fluoroscope, and it is easier to catch the needle in the middle than by an end. Also the forceps generally have some tissue within their grasp, which would prevent their withdrawal.

While the technic described is simple in principle, it is not equally so in practice. Locating and grasping the needle under the fluoroscope is difficult for those not accustomed to work in this medium. To a certain extent this is a blind maneuver but if the forceps are kept closed until in contact with the needle there is relatively little danger of doing any damage. There is some added difficulty in maintaining sterile technic under the fluoroscope. This is accomplished by adequate drapes; a sterile towel may be placed under the screen.

SUMMARY.—A technic is presented for the atraumatic removal of a needle from the hand. The needle is located and grasped with forceps under the fluoroscope. It is manipulated so that one end can be palpated under the skin. It is removed through a second incision.

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DISCUSSION.—DR. HARVEY B. STONE (Baltimore, Md.).—I have attempted to find needles in various parts of the body with no very great success. The hand is one of the most difficult places, and if Doctor Prioleau's method is successful I think he has brought out a very useful procedure.

DR. JAMES M. MASON (Birmingham, Ala.).—This is a rather unique and interesting procedure that Doctor Prioleau has reported. I had an interesting experience in the case of a piece of iron wire in the soft parts of the thumb. It gave him no trouble at the time of the accident but several weeks later the thumb became painful. A roentgenogram showed a good outline of the piece of wire in the ball of his thumb. I have manipulated a good many of these under the fluoroscope, but this seemed so simple that the fluoroscope was not used. I cut down and probed but never did find the wire. Another roentgenogram was made and there was no wire there. Through the process of oxidation or rusting, the wire had become entirely disintegrated, and the outline of the wire seen in the first roentgenogram was simply the iron rust which had remained in the tissues.

MEMOIRS

HERBERT PHALON COLE

1880-1935

HERBERT P. COLE, of Mobile, Ala., died while on a vacation in Miami, Fla., September 27, 1935, from a violent septic infection originating in a slight wound of a finger.

Coming at the height of his professional activity and usefulness, his death was a shock to his friends and a great loss to his community.



HERBERT PHALON COLE, M.D.

The *Mobile Register* said editorially, in part, concerning his passing: "The death of Dr. Herbert P. Cole in Miami yesterday deprives Mobile of the services of an eminent surgeon and a conscientious and useful public leader. In his nearly 30 years of residence in Mobile, Doctor Cole established for himself a distinguished reputation not only in medical circles, but in civic affairs. He was a citizen whom Mobile could ill afford to lose."

Doctor Cole was born in Minneapolis, Minn., September 2, 1880. He attended the high schools of Minneapolis and St. Paul, spent one year at the University of Minnesota, and was graduated from the University of St. Lawrence, at Canton, N. Y.

He studied medicine at Johns Hopkins University, and received his M.D. degree in 1906. Following his graduation, he served as intern in the Johns Hopkins Hospital in the department of gynecology, under Drs. Howard Kelly and Thomas Cullen. He went from there to the Lakeside Hospital in Cleveland, where he served as intern in surgery for a period of 18 months under Dr. George W. Crile. His work under these distinguished surgeons and teachers was at a time when they were doing their most brilliant and inspiring work, and their influence was reflected in his entire professional career.

After completing his hospital training, Doctor Cole located in Mobile and became connected with the School of Medicine of the University of Alabama as Associate Professor of Gynecology, and continued his activities as a teacher until the school was removed from Mobile to the University campus at Tuscaloosa.

Doctor Cole had a distinguished War record, serving with the rank of Major in Base Hospital No. 15, Fortieth Division, and, overseas, in Evacuation Hospitals 9 and 10.

In addition to his wide professional activities, he was much interested in civic affairs, and served a term as president of the Chamber of Commerce of Mobile.

He was a member of the County, State, and American Medical Associations, and of the American College of Surgeons. In 1928, he was President of the Mobile County Medical Society, and at the time of his death was attending surgeon to the Mobile Infirmary.

In 1909, he was elected to membership in the Southern Surgical Association, and was a frequent contributor to its programs and took an active part in discussions.

On September 14, 1909, Doctor Cole married Miss Jessie Wells, of Canton, N. Y., who, with two sons, survive him.

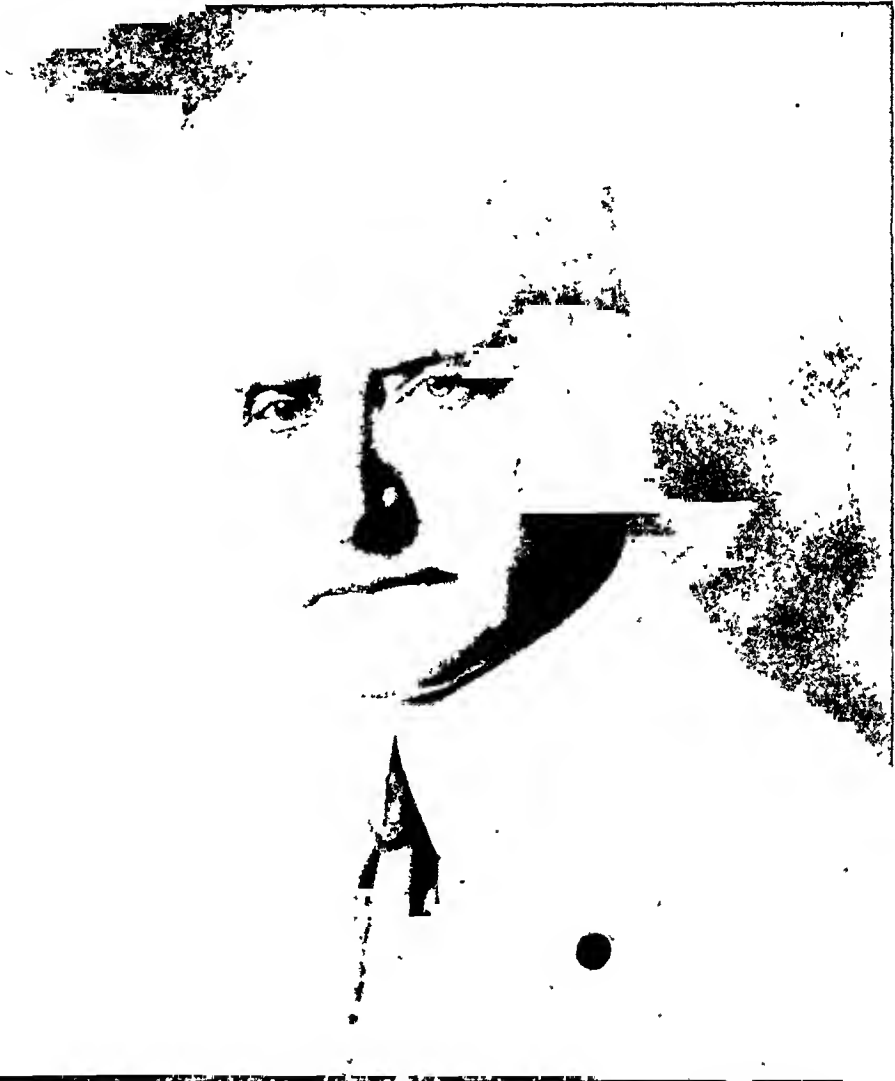
JAMES M. MASON

FRANKLIN H. MARTIN

1857-1935

"The nobler type of man is vexed at his want of ability, not because others do not appreciate him." *Confucius*, xv: 18.

THE life of Franklin H. Martin was characterized by courage. He was born with the hardy spirit of two pioneer families, each of which came west by caravans into the rugged wilderness of Wisconsin. The loss of his



FRANKLIN H. MARTIN, M.D.

Moffett Studio

father in the Civil War when he was five years of age; the remarriage of his mother and the happy union of two families of children; the struggles and sacrifices necessary to obtain his elementary education; his labors as farmhand, brickmaker, carpenter, janitor and, finally, school teacher are mute evidence of an indomitable courage to improve his abilities. To the man

so engaged from childhood in the attempt to increase his knowledge that its practical application might be of some benefit to his fellow men, there is little time left for vexation because others do not appreciate him. His early medical education is a recital of those exciting days which saw the advent of antiseptic surgery and the bacteriologic theories of medicine. His early medical career in Chicago was spent among men who were frank in discussion and whose chief attraction was fearlessness and their ability to make fast friends and implacable enemies, but to the latter they exhibited a spirit of fairness born of their own moral courage.

Early in his surgical career he became imbued with the idea of the need for dissemination of the rapidly increasing contributions to modern surgery. This thoughtful consideration of the actual workers in surgery who were distant from teaching centers, was the motivating factor of his life and will be recognized as the greatest contribution he made to surgical progress. The organizations for the elevation of the standards of surgery and the continuous education of all surgeons may change with the advancement of years but the courage to put into effect the basic principles of that idea, often against obstacles which would have deterred a less courageous man, showed a character devoted to the welfare of his fellowman. His Autobiography records these efforts in a manner typical of the untiring energy and industry of the man.

Fundamentally an idealist, he was extremely sensitive and was reluctant to approach people or speak in public to a degree that to many seems unbelievable. "Have the courage to do the thing you believe to be right but that you are afraid to do." This slogan, together with an ability to arrive at a logical conclusion with incredible speed, drove him forward with an impatience that to many gave the impression that his actions were often autocratic. Few men have been more misunderstood by those unwilling to withhold a quick judgment. From the very start there was no appeal for sympathy for the early hardships endured, no appeal for pity, but throughout only a steadfast, honest hewing to the line of what he considered to be his small contribution to the progress of his chosen profession. The final judgment of the surgical world will stand as his monument.

LOYAL DAVIS

EDITORIAL ADDRESS

Original typed manuscripts and illustrations submitted to this journal should be forwarded prepaid, at the author's risk, to the Chairman of the Editorial Board of the ANNALS OF SURGERY

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REPORT OF THE COMMITTEE TO STUDY FURTHER PROBLEMS OF POSTGRADUATE SURGICAL EDUCATION IN GENERAL AND THE QUALIFICATIONS FOR SPECIALIZATION IN GENERAL SURGERY IN PARTICULAR*

EVARTS A. GRAHAM, M.D.

St. Louis, Mo.

FOLLOWING the splendid series of papers on the training of the surgeon which were presented at the last meeting, your President, Doctor Archibald, appointed a committee to take such steps as seemed necessary to organize increased facilities for the training of surgeons and to arrange for the certification to the public of properly qualified surgeons. The committee consisted of Drs. Edward W. Archibald, Arthur W. Elting, Evarts A. Graham, Thomas M. Joyce, Thomas G. Orr, and Allen O. Whipple. After some preliminary consideration and correspondence among the members of the committee it seemed probable that it would be necessary to organize a qualifying board of some sort to take care of the certification of surgeons to the public. It also seemed advisable to obtain the cooperation of other surgical societies in this movement. Shortly after the appointment of the committee of the American Surgical Association a committee was appointed by the Surgical Section of the American Medical Association to consider the same matters that were the business of your committee. The group appointed by the American Medical Association consisted of Drs. Fred W. Rankin, *Chairman*, Henry W. Cave, Brien T. King, Roy D. McClure, J. Stewart Rodman, and Hugh H. Trout. Your chairman discussed the matter with the chairman of the Executive Committee of the American College of Surgeons, Dr. George W. Crile, in an effort to enlist the cooperation of the College of Surgeons. As a result of this conversation a meeting was held in Chicago on October 23, 1935, at the building of the American College of Surgeons, at which were present the committees representing the American Surgical Association and the Surgical Section of the American Medical Association, together with representatives of the American College of Surgeons as follows: Drs. George Crile, J. Bentley Squier, Samuel C. Harvey, Irvin Abell, and B. C. Crowell. At a meeting of the

* Committee appointed by the American Surgical Association at Boston, Mass., June 8, 1935. Evarts A. Graham, M.D., St. Louis, Mo., Chairman.

American Surgical Association Committee held in the morning of that day at the Stevens Hotel, Chicago, and preceding the meeting with the other committees, it was decided that very probably it would be found necessary to organize a qualifying board which should be national in scope. As a means of getting action started the following resolution was adopted by your committee and at the afternoon meeting it was presented to the American Medical Association Committee and the representatives of the College of Surgeons:

A committee appointed by the American Surgical Association to consider the elevation of standards of the practice of surgery and to increase the hospital facilities for the training of young surgeons, proposes that a joint national committee representing the various surgical organizations of the country be formed to discuss and arrange a program for accomplishing those objects. The committee proposes that a national committee of 24 members be formed for this purpose, consisting of six members representing the American College of Surgeons, six the American Medical Association, six the American Surgical Association, two the Western Surgical Association, two the Southern Surgical Association, and two the Pacific Coast Surgical Association. It is hoped that the American College of Surgeons will cooperate in the proposed endeavor by appointing six members to serve on the national committee to organize this work.

After rather prolonged discussion the representatives of the American College of Surgeons agreed to cooperate in this movement, at least to the extent of appointing six members to serve on the proposed National Committee of 24, to discuss ways and means of creating a suitable organization to take care of the qualification of surgeons.

The representatives chosen by the American College of Surgeons to serve on the National Committee were Drs. Samuel C. Harvey, *Chairman*, Irvin Abell, Donald Guthrie, Allen B. Kanavel, C. Jeff. Miller, and Alexander Munroe.

A meeting of the large committee of 24 members was held in Chicago on February 15 and 16 at the Palmer House at which the following were present: Drs. Thomas G. Orr, Allen O. Whipple, and Evarts A. Graham representing the American Surgical Association; Irvin Abell, Samuel C. Harvey, and Alexander Munroe, of the American College of Surgeons; Brien T. King, Roy D. McClure, Fred W. Rankin, J. Stewart Rodman, and Hugh H. Trout, of the Surgical Section of the American Medical Association; Reginald Jackson and Erwin Schmidt, of the Western Surgical Association; and Robert L. Payne and Mont R. Reid, of the Southern Surgical Association. The two representatives from the Pacific Coast Surgical Association could not be present. The New England Surgical Society was not invited to send representatives to the meeting of the National Committee because it would have been necessary to wait for nearly a year for that Society to select its representatives.

The committee organized itself by the election of officers as follows: Drs. Evarts A. Graham, *Chairman*; Samuel C. Harvey, *Vice-Chairman*; and J. Stewart Rodman, *Secretary*. After some preliminary discussion the chairman appointed two subcommittees to meet separately and submit reports be-

fore the joint committee on the morning of February 16 on (1) a plan for the organization of an American Board of Surgery, and (2) a plan for increasing the opportunity for the training of surgeons. Dr. J. Stewart Rodman was appointed chairman of the subcommittee for proposing a plan of organization of the American Board of Surgery. Others of those present who were appointed to serve with him on that subcommittee were Drs. Abell and Munroe, of the American College of Surgeons; King and Rankin, of the American Medical Association; Schmidt, of the Western Surgical Association, and Reid, of the Southern Surgical Association. The chairman of your committee also worked with that subcommittee. Dr. Samuel C. Harvey was appointed chairman of the subcommittee to consider ways and means of increasing facilities for the training of surgeons. Those who served with him on that committee were Drs. Whipple, of the American Surgical Association; Guthrie, of the American College of Surgeons; McClure and Trout, of the American Medical Association; Jackson, of the Western Surgical Association; and Payne, of the Southern Surgical Association.

The reports of the two subcommittees were submitted to the joint committee on February 16 and they were unanimously accepted. The chairman and secretary of the National Committee were authorized to present the plan for the creation of an American Board of Surgery to the Executive Committee of the Advisory Board for Medical Specialties which was scheduled to meet that evening at the Palmer House. The plan was presented to that body and discussed by the chairman and secretary of the committee as authorized and also by Dr. Allen O. Whipple. It was approved by that body.

AMERICAN BOARD OF SURGERY

The details of the plan for the organization of the proposed American Board of Surgery will be worked out by the Board itself. In making the present report we shall limit ourselves to a brief presentation only of the general plan.

It is perhaps not generally appreciated that there are already nine boards representing different medical specialties actively functioning. These boards are respectively for ophthalmology, otolaryngology, obstetrics and gynecology, dermatology and syphilology, pediatrics, psychiatry and neurology, radiology, orthopedic surgery, and finally urology. Recently to this board has been added the newly created American Board of Internal Medicine. All of these various boards have joined with certain national organizations to create the Advisory Board for Medical Specialties which functions in conjunction with the Council of Medical Education and Hospitals of the American Medical Association. The national organizations which have joined with the special boards to form the Advisory Board are the Association of American Medical Colleges, the American Hospital Association, the Federation of State Medical Boards of the United States and the National Board of Medical Examiners. In developing the plan for the proposed American Board of Surgery the scheme of organization of some of the other specialty boards has been followed

in the main. In one respect, however, the proposal for the creation of an American Board of Surgery differs from the plan of organization of some of the other boards in that the responsibility for the American Board of Surgery will rest with the large national and regional surgical associations. For example, it is proposed that the board shall consist of 13 members allocated as follows:

The American Surgical Association.....	3
The Surgical Section of the American Medical Association.....	3
The American College of Surgeons.....	3
The Southern Surgical Association.....	1
The Western Surgical Association.....	1
The Pacific Coast Surgical Association.....	1
The New England Surgical Society.....	1
	<hr/> 13

It is proposed that each member of the Board shall serve for six years except that lots shall be drawn by the original members of the Board to select certain ones to serve for six years, others for four years and still others for two years in order that a continuity of membership may be preserved so that at the end of six years an entirely new board will not take the place of the old one. It is proposed that a group of Founders be selected to be qualified without examination and that those eligible for the Founders Group will be those holding, when this board begins to function, active and senior membership in the American Surgical Association, the Southern Surgical Association, the Western Surgical Association, the Pacific Coast Surgical Association, and the New England Surgical Society; also professors of surgery, clinical, associate and assistant professors of surgery in all Class A medical schools of the United States and Canada; in addition within the first two years after the Board begins to function, those who have limited their practice to surgery for 15 years may make direct application to the Board and with its approval be certified without examination.

Other candidates who will be qualified by the Board will be expected to present themselves for examination after having fulfilled certain requirements, one of which is that which concerns special training. In the proposed plan the special training shall consist of a period of graduate study of not less than three years beyond the intern year, if taken in a recognized graduate school of medicine, or in an hospital or under a sponsorship accredited by the American Board of Surgery for the training of surgeons. This period of specialized preparation should include sufficient graduate training in anatomy, physiology, pathology, and the other basic medical sciences as are essential to the proper understanding of the practice of surgery, as well as adequate operative experience, evidence of which may be required by the Board. An additional period of not less than two years of study or practice in surgery is required as well.

It is important to note the fact that in the specialized period of training the committee feels that there should be an adequate operative experience.

It would seem far more reasonable to have the surgical neophyte begin his operative experience in an hospital where he will be under supervision than to turn him loose on an unsuspecting public, after an inadequate period of preparation, to acquire his operative experience without supervision which would result, in many instances, in unnecessary deaths and in increased morbidity.

It is proposed that the examinations be divided into two parts of which one will be written and the other practical, covering bedside work, clinical, and operative features. It is also proposed by the committee to have the examinations organized in such a way that part of the practical examination can be devoted to special fields of surgery such as neuro, thoracic, and plastic surgery in order that properly selected candidates may be awarded certificates of qualification in those special fields after they have presented evidence of a satisfactory training and experience in the general field of surgery.

It is proposed that the fee to be paid by members of the Founders Group shall be \$25.00 and that a total fee of \$75.00 be asked of those who propose to qualify themselves by examination. After the payment of the fees there will be no further dues of any kind. Certificates of qualification by the American Board of Surgery will be issued to the members of both the Founders Group and of the group qualified by examination, after the completion of the payment of the required fees.

Many of the details of conducting the business of the Board will necessarily be determined after it has been organized and after it has created its constitution and by-laws. It would seem wise at this time not to enter into too much discussion of details because they can be better settled by a small group.

A fear has been expressed by some that such a board as planned might attempt to create more standardization of the teaching and practice of surgery than would be desirable. Certainly a too sharply standardized plan of education would be unfortunate. On the other hand, the very method of organization of the board would seem to protect it from the possibility of too much continuous influence in any direction since the members will serve for only six years and will be answerable to their representative organizations which have appointed them. If the Board is not functioning in a proper manner it will be easy enough in the space of two or four years to change its composition to such an extent that a dangerous policy will no longer be continued.

Increasing the Facilities for the Training of Surgeons

It has already been stated that a special subcommittee of the National Committee was appointed under the chairmanship of Dr. Samuel C. Harvey to consider ways and means of enlarging the present facilities for the training of surgeons. In the report of that special committee, which was unanimously adopted by the National Committee, the following recommendations were made.

The American College of Surgeons and the American Medical Association should be asked to form a joint council to organize and carry out a program for the training of surgeons in properly qualified hospitals, setting up such

standards as will meet the requirements of the proposed American Board of Surgery. The standards for the proper training of surgeons shall be subject to the approval of the American Board of Surgery.

The committee also expressed the opinion that in order to provide an adequate number of properly trained surgeons, certain hospitals not now associated with teaching institutions must be developed to the point of carrying out such training. It is hoped that the various hospital associations now organized will give their hearty support to this movement. The committee also emphasizes the fact that a proper graduate training for surgery involves a carefully directed and supervised apprenticeship during which the student should actively participate in practical surgical work, including the performance by himself of operative procedures. He must also have the opportunity at the same time to increase his basic knowledge of the fundamental medical sciences and he must have a thorough and comprehensive training in surgical pathology.

In order to accomplish such purposes the committee feels that hospitals which are selected as being suitable for the proper training of young surgeons should have a type of organization and the facilities which would permit the giving of the training sought. For example, such a hospital must have a continuous ward service of non-private patients under the control of a director, or the equivalent of this, who is responsible for carrying out the program of training of surgeons. This director and his staff must be competent and interested in teaching and willing and able to devote the necessary amount of time to this. It is essential that the relationship between the student and the teacher be a constant and intimate one so that the work of the former is under constant supervision and guidance. It is essential also that such hospitals should have adequate outpatient clinics including follow up and "combined clinics" of which the Tumor Clinic as outlined by the American College of Surgeons is an example. The equipment and facilities of such hospitals must be of proven standards and include adequate laboratories in radiology, pathology, bacteriology, and similar facilities for diagnosis. There must also be an adequate record system and a proper library easily available to the student. Periodic conferences are essential, particularly in relation to the current surgical pathology, the diagnostic problems and the unfavorable results of therapy. Of the greatest importance is the obtaining of autopsies and much emphasis must be laid on the proper ratio between these and the mortality.

It will probably be necessary to have careful and competent periodic surveys of the hospitals designated as suitable for the training of surgeons in order to ascertain that the training is being properly accomplished. Such surveys can be carried out only by surgeons who themselves have been qualified by the Board, are of mature judgment and command the respect of those undertaking to train young surgeons. It is probable also that the progress of the student and the effectiveness of the instruction should be checked by periodic reports to the Council from both the director who is responsible for the teaching in the individual hospital and the men who are students under him.

Recommendations to the American Surgical Association

If the American Surgical Association approves of the report of its committee your committee would suggest that formal approval of the two general suggestions contained in the report be made by the Association. These are, first, the approval of the plan for the creation of an American Board of Surgery and, second, the approval of the suggestion that a recommendation be made to the American College of Surgeons and the American Medical Association that a joint council be organized for increasing the facilities for the adequate training of young surgeons. Again if the Association expresses its approval, the Council of the Association can then consider the matter of the appointment of three members to serve on the proposed board.

As a matter of information your committee is pleased to announce that the Pacific Coast Surgical Association and the executive committee of the New England Surgical Society have already gone on record as approving in principle the recommendations which the National Committee has made. They are the first organizations which have had an opportunity to act upon this important matter. The American Surgical Association will be the third one to have the opportunity to approve of the proposed plan. Your committee hopes that this Association, in which this movement was initiated, will express its approval of the general plans proposed.

EDWARD W. ARCHIBALD,
ARTHUR W. ELTING,
THOMAS M. JOYCE,
THOMAS G. ORR,
ALLEN O. WHIPPLE,
EVARTS A. GRAHAM, *Chairman*.

BACTERIOLOGIC STUDIES OF CHRONIC APPENDICITIS*†

BASED UPON 209 CONSECUTIVE CASES

DONALD C. COLLINS, M.D., M.S.

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CONTRIBUTIONS have been made to the study of the bacteriology of both acute and chronic appendicitis, but there have been few reports in the literature concerning bacteriologic studies of the serosa and muscularis of appendices removed surgically. It is apparent that cultures of the lumen alone can furnish only partial information as to whether these specimens were possible foci of infection.

Two hundred nine surgically removed appendices were used in this study. Immediately following an appendectomy, where the diagnosis of chronic appendicitis had been made by the surgical pathologist, the appendix was placed in a sterile basin with the hemostat left on its base. The basin was immediately covered by a sterile towel and taken to the pathologic laboratory. There, using sterile scissors and forceps, a portion of the serosa with the muscularis, measuring approximately 1 cm. in diameter, was removed from the distal third of the appendix. Great care was exercised to prevent entering the submucosal and mucosal layers. As a check on this step of the procedure, microscopic sections were made through the area from which the serosa and muscularis had been excised. If microscopic sections of that area revealed an entrance into either the submucosa or mucosa, that particular culture was discarded. The portion of the tissue excised was placed in a sterile test tube containing 5 cc. of sterile normal saline solution. The test tube was then placed in an incubator at 37.0° C.

All cultures thus taken were promptly carried to the bacteriologic laboratory and inoculated into culture media. All specimens in which a break in the aseptic technic occurred in their removal from the operating room to the laboratory were rejected. The excised serosa and muscularis were ground up in a sterile mortar with a small amount of sterile sand. The resulting serosanguineous fluid was then transferred into an empty sterile test tube which served as the original material from which cultures were made.

Five cultures were made on the following media: (1) Tall tubes of glucose-brain broth; (2) plain agar slants; (3) Endo's medium plates; (4) blood agar plates, and (5) blood agar slants, using Buchner's method to obtain anaerobic cultures. These five cultures, as soon as made, together with the original material, were placed again in the incubator at 37.0° C. for 24 hours. If no growth appeared, they were similarly examined for an additional three days and then if no growth was evident, they were discarded

* Research accomplished while a Fellow in Pathology and in Surgery, The Mayo Foundation, Rochester, Minn.

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with the exception of the glucose-brain broth culture, the anaerobic culture and the original material. These three cultures were kept for an additional four days, and if at that time there was still no growth, it was assumed that the cultures from that particular specimen were sterile.

All growths from an appendix which appeared in only one anaerobic culture medium and not in the others were assumed to be contaminations and were discarded from this series. All positive cultures were stained by Gram's stain and their morphology was noted. This information, as well as that derived from the Endo's medium plates, determined whether the use of various sugar media were required for the exact identification of the micro-organism. All gram-negative staining organisms were identified by their cultural reactions in various sugar media. Streptococci were identified by their growth in glucose-brain broth medium, upon blood agar plates and their morphologic appearance after being stained by Gram's method.

There were 34 (16.2 per cent) positive cultures obtained from the entire group of 209 cases. Seventy-five appendices (35.8 per cent) were partially obliterated. Sixteen (21.3 per cent) of these partially obliterated specimens produced positive bacteriologic cultures. One hundred thirty-four appendices (64.0 per cent) were not obliterated and this group furnished 18 positive cultures (13.5 per cent). Cases of total complete lumen obliteration were not included in this report. However, 92 such specimens were cultured in a separate study and all were sterile. 46.9 per cent of the positive cultures occurred in chronically inflamed appendices with an accompanying partial lumen obliteration. Appendices associated with other intra-abdominal disease produced 88.3 per cent of the 34 positive cultures obtained from the 209 consecutive cases of chronic appendicitis studied.

SUMMARY

Two hundred nine cases of chronic appendicitis, so diagnosed by the surgical pathologist, have been studied bacteriologically, culturing the serosa and muscularis and avoiding contact with the lumen. The method by which these cultures were taken and the criteria by which they were judged have been discussed. Tables are appended tabulating the various findings in this study. Thirty-four (16.2 per cent) positive cultures were obtained. 46.9 per cent of the positive cultures occurred in partially obliterated appendices and 88.3 per cent in appendices which were associated with other intra-abdominal disease demonstrated at operation by the surgeon. Ninety-two additional specimens which revealed total obliteration of the lumen, as proven by microscopic study, failed to produce a single positive culture.

TABLE I

POSITIVE BACTERIOLOGIC CULTURES IN 209 CASES OF CHRONIC APPENDICITIS

No.	Organisms Isolated	Pathologic Diagnosis
3	<i>Escherichia coli</i>	Chronic cholecystitis and cholelithiasis
8	<i>Escherichia coli</i>	Chronic appendicitis

TABLE I—*Continued*

No.	Organisms Isolated	Pathologic Diagnosis
10	<i>Escherichia coli</i>	Chronic cholecystitis
14	<i>Escherichia coli</i>	Chronic cholecystitis and cholelithiasis
2	<i>Escherichia coli</i>	Chronic duodenal ulcer, mucous colitis
9	<i>Escherichia coli</i>	Chronic duodenal ulcer
13	<i>Escherichia coli</i>	Chronic duodenal ulcer
19	<i>Escherichia coli</i>	Chronic duodenal ulcer
33	<i>Escherichia coli</i>	Chronic recurrent appendicitis
4	<i>Alcaligines fecalis</i>	Chronic cholecystitis and cholelithiasis
15	<i>Alcaligines fecalis</i>	Chronic cholecystitis
16	<i>Alcaligines fecalis</i>	Chronic duodenal ulcer
18	<i>Alcaligines fecalis</i> , <i>Staph. aureus</i>	Chronic cholecystitis and cholelithiasis
22	<i>Alcaligines fecalis</i>	Chronic cholecystitis and cholelithiasis
26	<i>Alcaligines fecalis</i> , <i>Esch. coli</i>	Perforated duodenal ulcer, chronic cholecystitis
27	<i>Alcaligines fecalis</i> , <i>Esch. coli</i>	Chronic cholecystitis and cholelithiasis
29	<i>Alcaligines fecalis</i>	Chronic cholecystitis and cholelithiasis, C.D. stone
7	<i>Streptococcus pyogenes</i> , <i>Esch. coli</i>	Obstructive lesion, descending colon
17	<i>Streptococcus pyogenes</i> .	Chronic duodenal ulcer
23	<i>Streptococcus pyogenes</i> , <i>Esch. coli</i>	Chronic duodenal ulcer
28	<i>Streptococcus pyogenes</i> .	Chronic duodenal ulcer, chronic appendicitis
30	<i>Streptococcus pyogenes</i> .	Chronic duodenal ulcer
25	Gram-positive aerobic spore form B	Chronic cholecystitis and cholelithiasis
31	Gram-positive aerobic spore form B	Chronic appendicitis
32	Gram-positive aerobic spore form B	Chronic cholecystitis and cholelithiasis
1	<i>Streptococcus fecalis</i> , <i>Staph. albus</i>	Chronic duodenal ulcer, chronic appendicitis
11	<i>Streptococcus fecalis</i> , <i>Esch. coli</i>	Uterine leiomyomata
6	<i>Staphylococcus aureus</i>	Chronic infectious arthritis
12	<i>Staphylococcus aureus</i>	Chronic cholecystitis
34	<i>Staphylococcus citreus</i>	Chronic cholecystitis
5	<i>Escherichia acid-lactici</i>	Endocervicitis, lacerated cervix
20	<i>Proteus liquefaciens</i>	Chronic cholecystitis, diverticulitis of colon
24	<i>Aerobacter aerogenes</i>	Chronic duodenal ulcer
21	<i>Eberthella enterica</i>	Chronic cholecystitis and cholelithiasis

Total.—34 positive cultures in 209 chronic appendicitis cases, using the serosa and muscularis for culturing; or 16.25 per cent of the series.

TABLE II

POSITIVE BACTERIOLOGIC CULTURES IN PARTIALLY OBLITERATED APPENDICES

No.	Organisms Isolated	Pathologic Diagnosis
3	<i>Escherichia coli</i>	Chronic cholecystitis and cholelithiasis
8	<i>Escherichia coli</i>	Chronic appendicitis
10	<i>Escherichia coli</i>	Chronic cholecystitis
14	<i>Escherichia coli</i>	Chronic cholecystitis and cholelithiasis
17	<i>Streptococcus pyogenes</i>	Chronic duodenal ulcer
28	<i>Streptococcus pyogenes</i>	Chronic duodenal ulcer, chronic appendicitis
30	<i>Streptococcus pyogenes</i>	Chronic duodenal ulcer
15	<i>Alcaligines fecalis</i>	Chronic cholecystitis
16	<i>Alcaligines fecalis</i>	Chronic duodenal ulcer
26	<i>Alcaligines fecalis</i> , <i>Esch. coli</i>	Perforated duodenal ulcer, chronic cholecystitis
6	<i>Staphylococcus aureus</i>	Chronic infectious arthritis
12	<i>Staphylococcus aureus</i>	Chronic cholecystitis

BACTERIOLOGY IN CHRONIC APPENDICITIS

TABLE II—*Continued*

No.	Organisms Isolated	Pathologic Diagnosis
25	Gram-positive spore forming aerobic B	Chronic cholecystitis and cholelithiasis
31	Gram-positive spore forming aerobic B	Chronic appendicitis
5	<i>Escherichia acidilactici</i>	Endocervicitis, lacerated cervix
24	<i>Aerobacter aerogenes</i>	Chronic duodenal ulcer

Total.—16 cases, or 46.88 per cent of 34 positive cultures.

75 appendices in the 209 cases were partially obliterated; or 36.0 per cent of series.

16 of these obliterated appendices had positive cultures; or 21.3 per cent.

134 appendices, or 64.0 per cent, were not obliterated in this series of 209 cases.

18, or 13.5 per cent, of the 134 cases of nonobliterated appendices had positive cultures.

TABLE III

RÉSUMÉ OF FINDINGS IN ENTIRE SERIES

A

Pathologic Diagnosis	No. Cases	Positive Cultures	Percentage Positive Cultures	
			Of Individual Condition	Of 209 Cases
Chronic appendicitis.....	60	4	6.66%	1.912%
Chronic duodenal ulcer.....	39	11	28.16%	5.258%
Chronic duodenitis.....	5	0	0.00%	0.000%
Chronic cholecystitis.....	37	5	13.50%	2.390%
Chronic cholecystitis with stones	46	10	21.20%	4.780%
Pelvic operations, Misc.	10	2	20.00%	0.956%
Chronic infectious arthritis....	2	1	50.00%	0.478%
Miscellaneous operations.....	10	1	10.00%	0.478%
Totals.....	209	34		16.252%

B

CASES GROUPED TO TYPE

	No.	Positive	Percentage Positive Cultures	
	Cases	Cultures	Of Individual Condition	Of Group
<i>I. Entire series: 209 cases:</i>				
Partially obliterated.	75	16	21.3%	7.65%
Not obliterated.	134	18	13.5%	8.60%
	<hr/>	<hr/>	<hr/>	<hr/>
Totals.	209	34		16.25%
<i>II. Cases with associated abdominal disease:</i>				
Partially obliterated.	60	13	21.6%	8.71%
Not obliterated.	89	17	18.7%	11.39%
	<hr/>	<hr/>		
Totals.	149	30		
<i>III. Cases of chronic appendicitis only:</i>				
Partially obliterated.	15	3	20.1%	4.98%
Not obliterated.	45	1	2.2%	1.66%
	<hr/>	<hr/>		
Totals.	60	4		

TABLE IV

SUMMARY OF MICROORGANISMS ISOLATED IN 209 CASES OF CHRONIC APPENDICITIS

Organism	Total Number	In Partially Obliterated Appendices	In Non-obiterated Appendices
<i>Escherichia coli</i>	14	5	9
<i>Alcaligines fecalis</i>	8	3	5
<i>Streptococcus pyogenes</i>	5	3	2
<i>Streptococcus fecalis</i>	2	0	2
<i>Staphylococcus aureus</i>	3	2	1
<i>Staphylococcus citreus</i>	1	0	1
<i>Staphylococcus albus</i>	1	0	1
Gram-positive aerobic spore forming bacilli	2	2	0
<i>Escherichia acidilactici</i>	1	1	0
<i>Proteus liquefaciens</i>	1	0	1
<i>Aerobacter aerogenes</i>	1	1	0
<i>Eberthella enterica</i>	1	0	1
Totals	40	17	23

TRANSACTIONS

OF THE

SOUTHERN SURGICAL ASSOCIATION

MEETING HELD IN HOT SPRINGS, VA.

THE BILE TRACT AND ACUTE PANCREATITIS

CHARLES R. ROBINS, M.D.

RICHMOND, VA.

ALTHOUGH the pancreas was first described by Wirsung in 1642, and Santorini made further studies and described the duct which bears his name before 1737, it was not until 1849, when Claude Bernard demonstrated the importance of the pancreatic juice in the digestive process, that the essential nature of the gland was understood. It was not until Opie, in 1901, studied his first case of acute pancreatitis and established the relationship between the bile tract lesions and the pancreas in the production of the pathology of pancreatitis that the different types of pancreatic inflammation, particularly acute pancreatitis, assumed a definite pathologic entity.

Clinical experience, however, soon demonstrated that the condition of a continuous channel, due to a blocking of the ampulla of Vater with a gall-stone, did not exist in all cases of acute pancreatitis, and there has been built up around this point a rather voluminous literature. It would not be possible in a brief paper to even allude to all the various contentions, experiments and clinical observations that have been made.

Only two points will be discussed at this time; one, the nature of the toxic product that causes the sudden and tragic death in such a large proportion of cases of acute pancreatitis, and, second, a consideration of the continuous channel theory.

THE POISON IN ACUTE PANCREATITIS.—It is admitted at the outset that no single sequence of events accounts for all cases of acute pancreatitis. We are concerned primarily with the most frequent causation.

Among the more prominent, the following views may be stated. Archi-

bald,¹ in 1921, stated that most of the evidence, both clinical and experimental, indicates that the entrance of bile into the pancreatic ducts is apparently the most frequent causative factor, and that bile salts in the presence of infection, the latter producing chemical changes in the bile, are responsible for the lesion. Eggers,⁵ in 1924, stated that infection as such has little or nothing to do with pancreatitis, but that the lesion is due to the action of liberated pancreatic ferments on the surrounding tissue.

Finney,⁶ in 1933, considered that the most important factor in producing the resultant destructive effect upon the pancreas, namely, the rapid edema, hemorrhage, and subsequent necrosis, which occurs almost immediately, is the bringing together within the body of the gland a mixture of pancreatic juice which contains, among other ferments, trypsinogen and certain activating substances such as bile, whether infected or not, and calcium, which is present in tissue exudate and blood plasma. He agrees with Archibald¹ that the pathologic process is primarily a chemical necrosis and the inflammatory changes purely secondary.

Dragstedt,⁴ in 1934, in a most extensive review of the previous literature, to which he adds the results of his own experiments, has set forth a series of conclusions which are most convincing, and which appear to me to be the true explanation of the phenomena that have been observed. He states it has been assumed that various factors cause the activation of the powerful proteolytic enzyme trypsin while it is still within the pancreatic substance or its ducts, and that the active trypsin then digests the living pancreas. Sweet, in 1915, and Moynihan, in 1925, have forcibly expressed this view. These theories are based on a misconception of the properties of enzymes: that is, they act as catalysts in that they can only accelerate a reaction which otherwise would take place slowly, whereas they cannot start a reaction which otherwise would not occur. The proteolytic ferments merely increase the rate of hydrolysis of proteins produced either by the dilute acid of gastric juice or by the dilute alkali of the pancreatic secretion.

Experimentally living pancreas was implanted in a window in the duodenum. No digestion took place whether the capsule was intact or not. This proved that living pancreas cannot be digested. The necrotizing action of bile on the pancreas was demonstrated by transplanting a free portion of pancreas in a window in the gallbladder, which caused acute necrosis of the portion of pancreas exposed to the bile. Under the action of bile there is an outpouring of serum and blood in the pancreas, which is of a protective nature. This is digested by activated trypsin and the tissues are free to be further acted upon by bile.

On the basis of existing evidence, Dragstedt states that it seems probable that approximately 60 per cent of the cases of acute pancreatitis occurring in man have developed as a direct result of the passage of bile into the pancreatic ducts.

As regards the cause of death in acute pancreatitis, Dragstedt considers

that according to the prevailing theories, it is due to a toxemia originating in some way from the diseased pancreas. He showed by cross circulation experiments into a normal animal, that there was an exceedingly rapid removal of toxic chemicals from the circulating blood, which explained the failure to demonstrate toxic effects by the transfusion of blood from an animal dying from acute pancreatic necrosis. This should not, however, be construed as proof of the absence of toxemia, as extracts of necrotic pancreas injected into the abdomen or veins of experimental animals have been shown to be exceedingly toxic. Further, he was able to prove by experiments that the absorption of the various constituents of the pancreatic juice from the peritoneal cavity were nontoxic if uncontaminated by bacteria; that the products of autolysis or digestion of the pancreas by activated pancreatic juice were nontoxic if sterilized by heat, but that if normal bacteria were not destroyed the toxicity was great. He states that it has been overlooked that there are regularly present in the pancreas of living and healthy rabbits and dogs, certain bacteria (predominantly anaerobes resembling if not identical with *C. welchii*), and that the toxemia is due to the presence of these bacteria. When the end-products of pancreatic digestion were autoclaved and introduced into the peritoneal cavity, there was no toxemia.

He therefore concludes that the initial injury to the pancreas is due to the necrosing effect of bile, that serum and blood are poured into the tissues as a protective measure. These are digested and the tissues are again subjected to the action of bile. The bacteria present in the pancreas proliferate in the necrotic material and split the proteins by their action. The cause of death is due to the split protein product rather than to the bacteria.

THE THEORY OF THE CONTINUOUS CHANNEL.—When Opie¹⁰ considered pancreatitis in 1903, a new impetus was given to the interest in this disease. His illustrations seemed to be quite convincing in establishing the effect of the continuous channel, and the flow of bile into the pancreatic duct was accepted as a causative phenomenon, without knowing exactly how it acted. As a result of this, cases were examined more carefully. It was found that while this phenomenon existed, it was not always present. Dragstedt⁴ estimates that, whereas 60 per cent of cases of acute pancreatitis are inaugurated by the action of bile, only 10 per cent are due to the blocking of the ampulla of Vater with a gallstone.

Other causes were sought for. The lymphatic route was first suggested, I believe, by Maugeret in 1908, and supported by Deaver,³ Judd,⁸ Graham,⁷ and others.

Archibald and Gibbons,¹ in 1921, published the results of their investigations and experiments in which they criticize the lymphatic theory and state that the conditions for actual serious damage to the pancreas must certainly be three. (1) A change in the bile composition, increasing the proportion of bile salts. (2) Undue resistance, perhaps often amounting

to spasm of the common duct sphincter (Oddi). (3) Abnormal rise in pressure in the biliary system behind, either in the gallbladder or the common duct. They conclude, in reference to the sphincter of Oddi, that the common duct sphincter is provoked to resistance, not only by acidity but also by a sudden distension of the common duct through abnormal and unexpected rise of pressure within the gallbladder.

In 1923, Mann and Giordano⁹ published the results of their experiments and investigations, which included the anatomic arrangements of the ducts, experiments to determine the normal pressure in the bile ducts and what causes it, and the effect of bile when introduced into the pancreas under various pressures. Their observations were based on 200 consecutive autopsies, and included not only the anatomic relations but also the action of the sphincter of Oddi. In reference to the latter, they conclude that there is so much variation in the relations of the different structures in this region there is always the possibility that in a few instances the sphincter might close the exit of the ampulla. They further conclude that an anatomic and physiologic basis for the theory that reflux of bile can occur into the pancreatic ducts does exist, that the evidence indicates that such a reflux of bile can rarely be the cause of chronic pancreatitis, but that their data conclusively prove that we must look elsewhere for the explanation of the cause of most cases of pancreatitis.

In 1929, Cameron and Noble² published the result of their investigations on fresh cadavers. They criticize the work of Mann and Giordano because it was done on fixed specimens, and are of the opinion that the importance of variations of a few millimeters would not obtain in living subjects. They maintain that the variations in the shape of gallstones will permit them to occlude the orifice of the ampulla when partially extruded. They used casts of the ducts made from Wood's metal. On a basis of 100 cadavers examined, they conclude that an ampulla of Vater is present in approximately 75 per cent of persons and that it is anatomically possible for a biliary calculus, lodged in the ampulla of Vater, to cause a reflux of bile into the duct of Wirsung in approximately 65 per cent of cases.

It would seem from the evidence at hand that chronic pancreatitis and acute pancreatitis are two different conditions. Chronic pancreatitis is quite common and is doubtless most frequently the result of infection through the lymphatic system. Acute pancreatitis, on the other hand, occurs infrequently, is sudden, destructive to the pancreas, and frequently fatal. It is reasonable to conclude that it is due to a combination of circumstances that are apparently infrequent.

The case which I wish to report is one in which a patient died of acute pancreatitis without operation, and in whom the autopsy revealed a large number of small gallstones which filled the gallbladder, hepatic, cystic and common ducts, and were also present in the duct of Wirsung and even the branches of the pancreatic duct.

CASE REPORT

The patient was admitted in an unconscious state, in profound shock, with an uncountable pulse, cold extremities and a clammy sweat. A history of previous attacks of gallstone colic was obtained. The present attack began with severe pain around and above his navel. He was given morphine without relief which was repeated in 30 minutes, after which he appeared to obtain relief. A diffuse soreness persisted which was more marked above the umbilicus. On the third day he had suppression of urine, which was

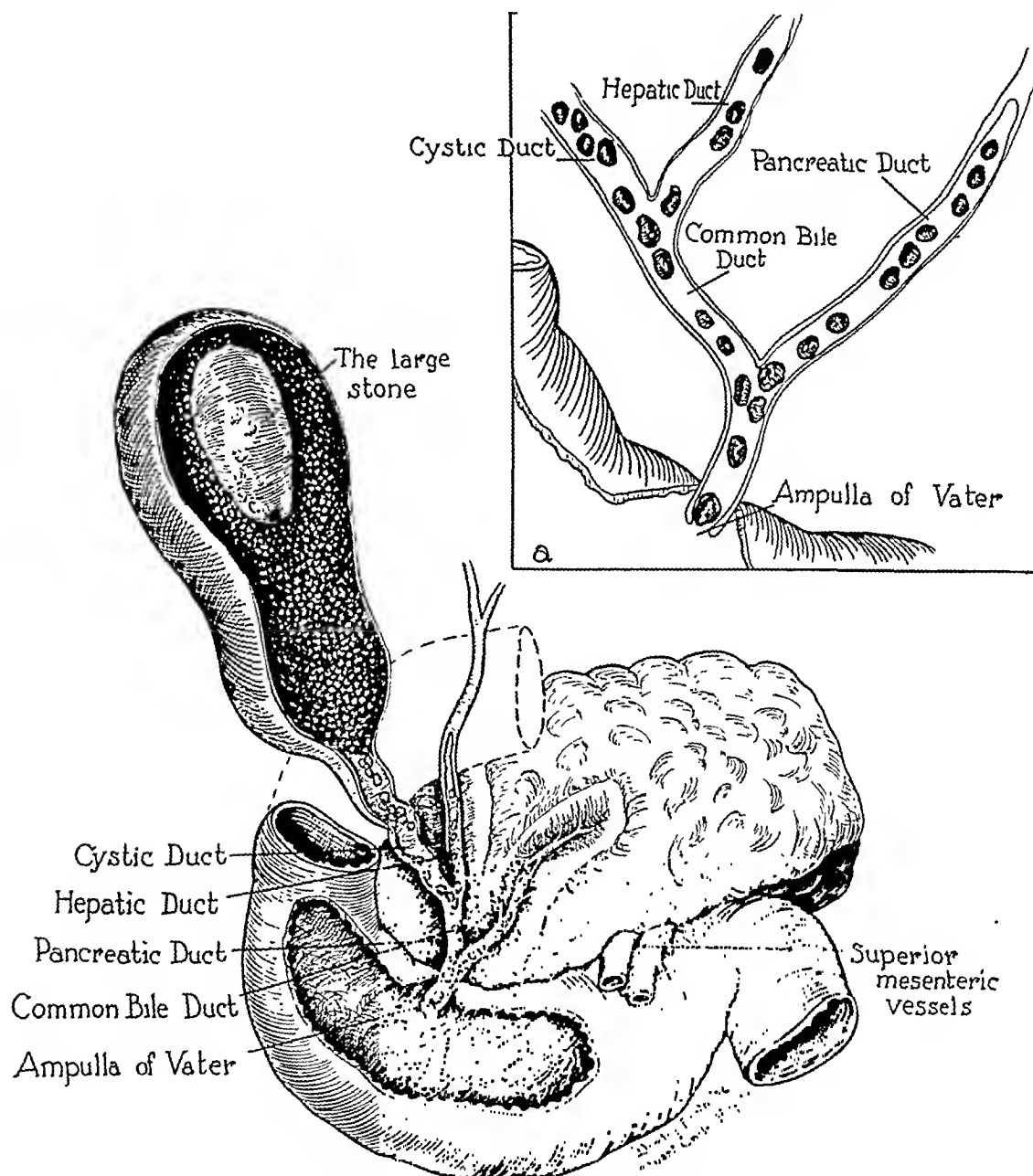


FIG. 1.—Drawing from specimen. Stones in pancreatic duct are similar in every way to those in gallbladder, and were composed of cholesterol.

overcome, but that night he commenced to vomit a thin, black fluid in large quantities and passed the same type of fluid from his bowels practically continuously.

The abdomen was distended but not rigid. Below the right costal margin the gallbladder could be palpated as a firm round body which confirmed the previous diagnosis of gallstones.

It did not appear that his condition would permit an operation and he was given intravenously 3,000 cc. of 5 per cent glucose in normal salt solution. The veins were so collapsed that it was necessary to expose the vein in order to introduce the needle.

This was followed by a distinct improvement and the patient became rational, talked of going fishing, and for the first time his pulse could be counted. His blood pressure which could be obtained for the first time was 60 systolic. However, the improvement was only temporary and he died within 14 hours.

Autopsy.—The small intestines were distended and in places discolored with purple splotches. There were large quantities of a thin odorless beefbroth fluid filling all the dependent areas. Fat necrosis was extensive, involving the omentum, abdominal parietes and the mesenteries, and even the fat in the abdominal wall. In the region of the pancreas the enveloping tissues were very much thickened by edema and of a dusky color.

The pancreas was enlarged, of a dusky color and necrotic. The gallbladder contained a large palpable stone and was distended with a number of small stones and bile.

The gallbladder, ducts and adjoining sections of the pancreas and duodenum were removed *en masse* for the purpose of study. Subsequent dissection disclosed a large stone and a number of small pearl-like gray-green stones in the gallbladder, the hepatic, cystic and common ducts. A stone was impacted in the ampulla of Vater. The same type of stone was also found in the pancreatic duct and apparently in its radicles, as the stones were encountered in the substance of the gland on section. They were typical cholesterol stones (Fig. 1), the smaller ones measuring from 2 to 5 Mm. in diameter. Several were examined by Dr. J. C. Forbes of the Medical College of Virginia and found to be practically pure cholesterol stones.

CONCLUSIONS

(1) The living pancreatic gland and other living tissues cannot be digested by the pancreatic enzymes.

(2) Pancreatic tissue, pancreatic juice and the products of pancreatic digestion are nontoxic if the bacteria in the tissues have been killed by autoclaving or the bacteria in fluids removed by passing through a Berkefeld filter.

(3) The pancreas and liver have been found to contain bacteria similar or identical with the *C. welchii* in tissue taken from living healthy animals.

(4) The toxic effect previously observed from implanting pancreatic tissue aseptically is due to the action of these bacteria contained in the tissue.

(5) All experimental observers seem to agree that the continuous channel may be produced, at least in a limited percentage of cases, by either blockage of the ampulla of Vater with a stone or by the contraction of the sphincter of Oddi. This should be considered in connection with the fact that acute pancreatitis occurs in a limited number of individuals.

(6) It is difficult or impossible to produce experimentally all the variations in the human duct systems.

(7) The case reported exhibits a condition accomplished by nature, in a living subject, that would seem to be impossible of accomplishment experimentally.

(8) The importance of bile in acute pancreatitis lies in the fact that it initiates the necrosis. Following this, serum and blood are poured into the tissues as a protective measure. These are in turn digested by the pancreatic ferments, freeing the tissue for fresh action by the bile. The bacteria flourish in the necrotic tissue and produce toxins themselves but the greatest toxemia results from the split products derived from the protein tissues.

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DISCUSSION OF THE PAPERS OF DOCTORS BAILEY AND ROBINS

DR. ROY D. McCLURE (Detroit, Mich.).—Too many medical men to-day are apt to think that stones in the gallbladder are innocuous unless they are causing gallstone colic. This is perhaps because one sees in our autopsy cases gallbladders containing stones which have shown no clinical symptoms and at the postmortem very few pathologic changes beyond a chronic cholecystitis. In our experience at the Henry Ford Hospital we have had about 40 cases of cancer of the gallbladder, and in every one of them there were stones in the gallbladder as a precursor of this cancer. Recently we have had two cases of intestinal obstruction which were due to large gallstones which had perforated into the intestine and lodged at the ileocecal valve. In our experience we have had disappointments in cases in which we have removed a diseased gallbladder for arthritis, but have had enough good results to show that cholecystectomy for chronic cholecystitis is of great value in the treatment of some cases of infectious or atrophic arthritis.

We have had some experience with undulant fever which is far from a rare disease in Michigan and the literature suggests that a focus of the infection may be maintained in the gallbladder. We have removed gallbladders in these cases but with no striking results, nor have we found a positive culture for *Brucella abortus* in the bile or gallbladder walls.

We are still occasionally surprised to get the culture report of "positive for typhoid bacillus" from stones submitted to the laboratory and cholecystectomy is today the most effective way of treating typhoid carriers. There is no more effective way of preventing a chronic or acute pancreatitis than removal of a diseased gallbladder and stones from the common duct. From my own personal experience, as well as that of many patients, I know that the removal of a gallbladder with stones may remove twinges of pain and discomfort that were previously interpreted by the patient as of cardiac or coronary artery origin.

On the whole, therefore, I feel that each patient with gallbladder disease should carefully be considered as, at least, a candidate for a cholecystectomy, not necessarily with the expectation of relieving any symptoms which he may have, but in the hope of prevention of more serious complications.

DR. GEORGE A. HENDON (Louisville, Ky.).—I have found that some active and aggressive measures for the purpose of drainage exercise a considerable degree of influence over the outcome of cases such as has been presented by both Doctor Bailey and Doctor Robins. An apparatus constructed, with certain refinements, on the pattern of the one that Doctor Wangenstein has presented, if connected with the urinary bladder by an indwelling catheter, will enable one to drain out as urine about all the water that individual will drink. I have had cases run four days and in that period only lose 50 cc. of the water the patient drank. It also takes out of the blood any excess of N.P.N., blood urea or creatinine. We have applied it to our gallbladder cases, and found that if this apparatus is attached to the tube in the gallbladder, drainage of the entire biliary tree will be effected.

In the case Doctor Robins has presented, I think that by our system of intravenous nutrition we are able to give complete rest to the pancreas, if we add one unit of insulin to each 6 Gm. of dextrose that is contained in the solution. This is mixed before it is introduced into the blood stream. The process is continuous and may be extended as long as one wishes. I think we have reached the time when it is no longer considered that our task is completed, when in an effort to drain we put one end of the drainage tube in the patient and lay the other end in the lap of Lady Luck.

DR. W. LOWNDES PEPLE (Richmond, Va.).—Reported a case upon whom he had operated for a gallbladder condition which he considered quite unique.

CASE REPORT

A woman, aged 47, gave a typical history of attacks of gallbladder colic which had occurred intermittently over a period of 22 years. There was never any fever or jaundice, and in the beginning they were not severe. In June, 1935, she had had two very severe attacks requiring several hypodermics of morphine for relief. Since then the attacks had been more and more frequent, and were accompanied by nausea and vomiting.

A flat roentgenogram showed two very suspicious shadows in the region of the gallbladder, the larger one occupying a position corresponding to the dome of the gallbladder and the other at a point corresponding to the cystic duct. The gallbladder filled and emptied normally. An oblique exposure showed the larger, upper shadow to lie outside the outlines of the gallbladder, but the smaller one apparently should have blocked the cystic duct. An intravenous pyelogram showed the kidneys to be functioning normally. With the normally functioning gallbladder and the two masses present we were forced to the conclusion that the upper stone was in an extraluminal pocket at the dome of the gallbladder, while the lower one probably lay in an ampulla which one often notes near the cystic duct.

At operation the gallbladder was found to be very thick, and deeply embedded in the liver. There was a mass in the dome and a small stone in the cystic duct. A cholecystectomy was performed. The convalescence was uneventful.

A roentgenogram of the specimen clearly outlines two gallbladders, the one containing a stone in the dome and also in its cystic duct, the other being quite clear. A gross section of the gallbladders shows the normal side stained deeply with bile, while the other is pinkish in color, and contains two stones and a quantity of semifluid detritus impregnated with calcium.

We have then a case of a diseased gallbladder with stones, occurring concomitantly with a normally functioning gallbladder. Had the stones been of the nonopaque variety the report of the roentgenologist would have been a normally functioning gallbladder. Dr. Hugh Trout, in 1933, reported a personally observed case, and reviewed 24 others.

DR. FRANK H. LAHEY (Boston, Mass.).—Doctor Arthur W. Allen, in 1934, reported on the value of dilating the sphincter of Oddi with metal dilators. If we could only dilate the sphincter of Oddi sufficiently so that the stones left behind would pass of themselves into the duodenum, it would obviate a great many difficulties, but in using this procedure by means of the Bakes dilators, we have seen two instances of ascending gas bacillus infection involve the liver and result fatally.

Doctor Allen tells me that they have done 200 dilations of the sphincter of Oddi with these dilators and have not had any gas bacillus infection. It may be that we employed too large dilators, although Doctor Allen states that they have used them up to the full size of the instrument.

It is certain that gas bacilli do exist in the duodenal contents and it seems certain, from our experience, that in some cases where the sphincter is overdilated that gas bacilli will ascend the common duct, infect the liver and result fatally. Having had these two actual experiences in our own practice, I am obligated, I feel, to report them in order that all of you may have them in mind if you undertake dilation of the sphincter of Oddi.

DR. WALTMAN WALTERS (Rochester, Minn.).—I would like to call attention to some of the things that are commonly unrecognized about stones in the common duct. First, in some cases of stone in the common duct jaundice may be absent, and second, that there are a group of patients who have stones in the common duct which produce intermittent fever, which is often described as the intermittent hepatic fever of Charcot. I have seen a number of patients in whom this clinical symptom was present and in whom there was no other symptomatic evidence of disease. On roentgenologic examination the gallbladder filled and emptied normally, and the decision as to the cause of the intermittent fever was reached only after exclusion, and even then it was not clear. Frequently in some cases of stone in the common duct the only symptom is that of pylorospasm, which is characterized by nausea and vomiting and occasionally by distress in the upper part of the abdomen after eating, with no other symptoms related to the biliary tract. In these cases there is usually loss of weight.

In operations upon the gallbladder, the common duct should always be palpated and inspected, and opened if it is dilated or thick-walled. I have never seen a case of stone in the common duct in which the duct was not enlarged or considerably thickened. Even in the absence of a history of jaundice or fever, such enlarged or thickened ducts should be opened and explored. In two-thirds of the cases the lower end of the common bile duct is surrounded by pancreas. A small stone in such instances frequently cannot be palpated.

Although I agree with Doctor Robins, I believe there is a common cause for inflammation of the pancreas. In 10 per cent of 400 cases of jaundice in which I have operated for benign lesions of the biliary tract, stone was absent from the common or hepatic ducts, the jaundice being due to obstruction of the duct from pancreatitis or cholangitis. This was recognized on cholecystographic examination, which I think is a very useful procedure. A substance opaque to roentgen rays, such as brominol or lipiodol, is injected into the common duct through the T-tube which drains it, and roentgenograms taken immediately and again ten minutes later will show whether or not there is still stasis in the lower part of the duct due to pancreatitis, which can be visualized, or to sphincteritis (inflammation of the sphincter of Oddi). These are all evidences that T-tube drainage should be continued.

As to the prevention of recurrences of stone in the common bile duct, time does not permit but the briefest discussion. Bacteriologic studies should be made of the bile found in the common bile duct when it is opened and explored and chemical analysis of these common duct stones should be carried out. Faceted stones in the common bile duct usually come from the gallbladder, but the soft, crumbly stone, composed of bile pigment, is usually formed in the common or hepatic ducts.

As the control of urinary infections and recurring renal calculi has been accomplished to a large extent by first identifying the organism associated with the stone, and then acidifying the urine by means of the ketogenic diet (in cases of bacillary infection), or by the use of certain arsenical preparations (in cases of coccal infections), so similar changes in the reaction of bile might eliminate the bacterial flora in it, even though such chemical changes in bile are much more difficult of accomplishment than in urine. However, with the halogenated phythaleins being excreted through the liver into bile, an antiseptic radical might be attached.

DR. CHARLES W. FLYNN (Dallas, Tex.).—Cited the appended case report as complementary to Doctor Bailey's paper.

CASE REPORT

In August, 1935, an elderly woman was admitted to the Baylor hospital, complaining of a long disability caused by pain in her left leg. She had spent most of the last eight months in bed, had lost considerable weight and was unable to sleep on account of the pain. She also complained of some indigestion and pain in the epigastrium. Over a period of several days many of the ordinary methods of treating sciatica were carried out without result. A gallbladder visualization was effected which showed a diseased gallbladder, apparently distorted by adhesions. The patient had had her teeth and tonsils removed, her sinuses were negative, the Wassermann was negative, and no other focus of infection could be found, which might be influencing the pain, except that apparent in the gallbladder. I advised its removal.

Through an upper right rectus incision an exploration of the upper abdomen demonstrated an adherent gallbladder, which was apparently closing an impending perforation of a duodenal ulcer near the pyloric ring. The gallbladder had a few small stones in it. The appendix was rather fat and edematous. There were some adhesions about the left tube and ovary. These adhesions were released, the gallbladder and appendix were removed, and a posterior gastroenterostomy was performed.

The almost immediate relief from pain in the leg was spectacular. Convalescence was uneventful, and three months later the patient was entirely normal, and quite free from any sciatic pain.

DR. JOHN C. A. GERSTER (New York, N. Y.).—Cited two cases in which the gallbladder was apparently the etiologic factor.

CASE REPORT

Case 1.—A woman, aged 67, stated that she had become unconscious while sweeping the sidewalk, and had sustained a broken hip. The fracture was reduced and a plaster encasement applied. The control roentgenograms were satisfactory.

Six weeks later she began to show signs of mental impairment, which occurred only during the night. There was no fever or other symptomatology. The neurologist considered it a form of senile psychosis. She became rapidly more confused and quite unmanageable. The internist decided that the right heart was decompensating and that the liver was enlarged, which accounted for the pain which she complained of on her right side. The day following this examination, a pear-shaped enlargement, correspond-

ing to the position of the gallbladder, could be felt. A cholecystectomy was performed under local anesthesia. A large, thick-walled gallbladder was removed. The common duct was not dilated. Her irrational mental condition subsided immediately.

It was later ascertained that she had had indigestion and "bilious attacks" for 25 years, and that she had had an attack of thickened speech the day preceding her accident. Possibly fracture of the femur, therefore, might be considered as one of the complications of gallbladder disease.

Case 2.—A woman, aged 67, was seen who complained of abdominal pain and vomiting. There was no fever or visible peristalsis. A flat roentgenogram showed distension of some loops of small intestine. At operation nothing was discovered to account for her condition until, on freeing the lower edge of the omental apron, hile was discovered. The fibrinous tract was traced up along the mesial border of the ascending colon and the gallbladder was found to be covered with fibrin. No attempt was made to determine its cause. The gallbladder was drained. After the hiliary fistula had healed, the gallbladder, containing one large stone, was removed.

DR. J. TATE MASON (Seattle, Wash.).—Because of the wave of enthusiasm for dilating the ampulla of Vater, we tested the procedure on a number of cadavers to ascertain how far it could be carried without tearing the mucous membrane. It was found that if dilatation was made beyond 5 Mm., it ruptured. I think Doctor Lahey's observation and warning about 11 Mm. very timely. We found that although one put his hand on the opposite side, in order to feel certain that the dilator was in the duodenum, it was occasionally not in the duodenum at all, but simply pushing the sphincter of Oddi forward without passing through it. Accordingly we had dilators made on the same pattern as these but with a hollow handle. In doing a dilatation, after we felt that the sphincter of Oddi had been passed, saline was flushed through the instrument. If the saline did not pass on into the duodenum but washed back through the duct we knew we had not passed the sphincter. I am told that another surgeon is using a similar type of dilator. I advise its use.

When we feel that the common duct is inadequately drained and that by passing these dilators through we may tear the ampulla of Vater, we prefer to perform a short-circuiting operation, and have devised a technic for accomplishing this, which we feel greatly facilitates the technical part of the anastomosis.

PRESACRAL NERVE RESECTION FOR THE RELIEF OF PELVIC PAIN AND DYSMENORRHEA

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SYMPATHETIC nerve operations for the relief of pelvic pain underwent a rather long evolutionary period. Beginning with the efforts of Jaboulay,¹ who, in 1898, after resecting the coccyx, made an incision in the perineum, resected a portion of one sacral sympathetic chain and divided the other for the relief of pelvic pain. A somewhat similar operation was done by him upon another patient. These operations were followed by temporary relief from pain in both cases. Postoperatively there was retention of urine for about 48 hours. A short time later Garrampazzi² carried out Jaboulay's technic in a patient with a somewhat similar result. The technical difficulties of the operation were rather great and the method was discontinued.

About a year later, without knowledge of the work of Jaboulay, Ruggi³ operated upon the pelvic sympathetic system by the transperitoneal route and divided the utero-ovarian plexus. This particular operation was also performed by Cavazzani,⁴ Toschini⁵ and Parlavecchio,⁶ all of whom published favorable results brought about by its performance. Jonnesco⁷ undertook to resect the ganglia of the sacral sympathetic chain with the same idea of relieving pain. These early attempts were not followed up by their authors and the impress made on the surgical world by this work was decidedly of an ephemeral nature.

In 1913, Latarjet and P. Rochet⁸ proposed to relieve certain types of painful chronic cystitis by dividing the sympathetic nerve branches supplying the bladder and lower end of the ureter. Their first operations were too radical and resulted in permanent retention of urine. Later, Rochet did a partial bladder denervation with good results in five cases.

In 1920, Badulesco⁹ and Gomoiu¹⁰ began to attempt the relief of pain resulting from inoperable cancer of the uterus by interrupting the sympathetic fibers along the line of the internal iliac arteries by ligation, but their results were not very satisfactory. However, Leriche,¹¹ in 1921, performed a peri-arterial sympathectomy of the iliac arteries with a view to the relief of dysmenorrhea and trophic conditions of the external genitals, with considerable success. Later, he and Tisserand¹² began operating for the relief of pain in inoperable cancer, doing peri-arterial sympathectomies of either the iliac arteries or of the aorta.

In 1922, Hallopeau¹³ published a report of a case of severe neuralgic pain in the pelvis in which he resected the hypogastric nerves in addition to doing a peri-arterial sympathectomy with a successful result. In regard to

the old operation of division of the uterosacral ligaments, lately revived by Condamin,¹⁴ it was at first thought that the good results achieved were due to a mechanical change, but it is now quite certain that, in effect, the operation was a sympathectomy and that is undoubtedly the reason why it relieved pelvic pain.

Gaston Cotte,¹⁵ from 1921 to 1924, did a number of pari-arterial sympathectomies and also developed the idea of resection of the pelvic nerve, as had Latarjet and Rochet or the superior hypogastric plexus as Hovelacque¹⁶ suggested. He came to the conclusion that sympathectomy was more efficacious and much easier to perform than peri-arterial denervation. Likewise, Diez,¹⁷ in 1924, resected the lumbar sympathetic chain on either side; about this time Bittmann¹⁸ resected portions of the lumbosacral sympathetic chain along with the inferior mesenteric ganglia; the rami communicantes were divided by Gaza,¹⁹ also by Pieri²⁰ Lhermitte and Dupont²¹ began to denervate the ovaries, all with the idea of relieving pelvic pain.

In 1924, Cotte developed a standardized presacral sympathetic neurectomy and published a description of the technic of his operation. The year following, he reported the results of the operation and gave definite indications for the procedure. Since this time the use of the operation, more particularly in Southern Europe, has been widespread. The labors of Leriche, Cotte and Michon²² have been largely responsible for placing the procedure on its present sound surgical basis. Numbers of satisfactory results have been reported by many French, Italian, Roumanian, English and German surgeons, likewise by surgeons from Spain, Brazil, the Argentine, Switzerland, Poland, Russia, Finland, and Sweden. Series of successful cases have been reported in the United States by Adson and Masson,²³ Counseller and Craig,²⁴ DeCourcy,²⁵ Wetherell,²⁶ Pemberton,²⁷ Kindel,²⁸ Keene²⁹ and others.

Anatomy.—(1) The plexus submesenteric of Winslow³⁰; (2) the nervus uterinus magnus of Tiedemann³¹; (3) the plexus uterinus magnus of Frankenhäuser³²; (4) the presacral nerve of Latarjet and Bonnet; (5) the prelumbar nerve of De Rouville³³; (6) the superior hypogastric plexus of Hovelacque¹⁶ is, according to Elaut,³⁴ made up about as follows: Beginning in the plexus situated between the superior and inferior mesenteric arteries, to these nerve elements are added the intermesenteric nerves of Petit-Dutailis and Flandrin,³⁵ also lumbar sympathetic fibers from both sides, so that at the level of the inferior mesenteric artery these nerves divide into two distinct bundles—the inferior mesenteric plexus and the superior hypogastric plexus (Figs. 1 and 2).

According to Hovelacque, the superior hypogastric plexus is essentially a continuation of the inferior mesenteric plexus below the inferior mesenteric artery and includes the part of the plexus that extends from the superior part of the fourth lumbar vertebra to the middle of the first sacral vertebra, where it divides into two terminal plexuses called the right and left inferior hypogastric plexuses.

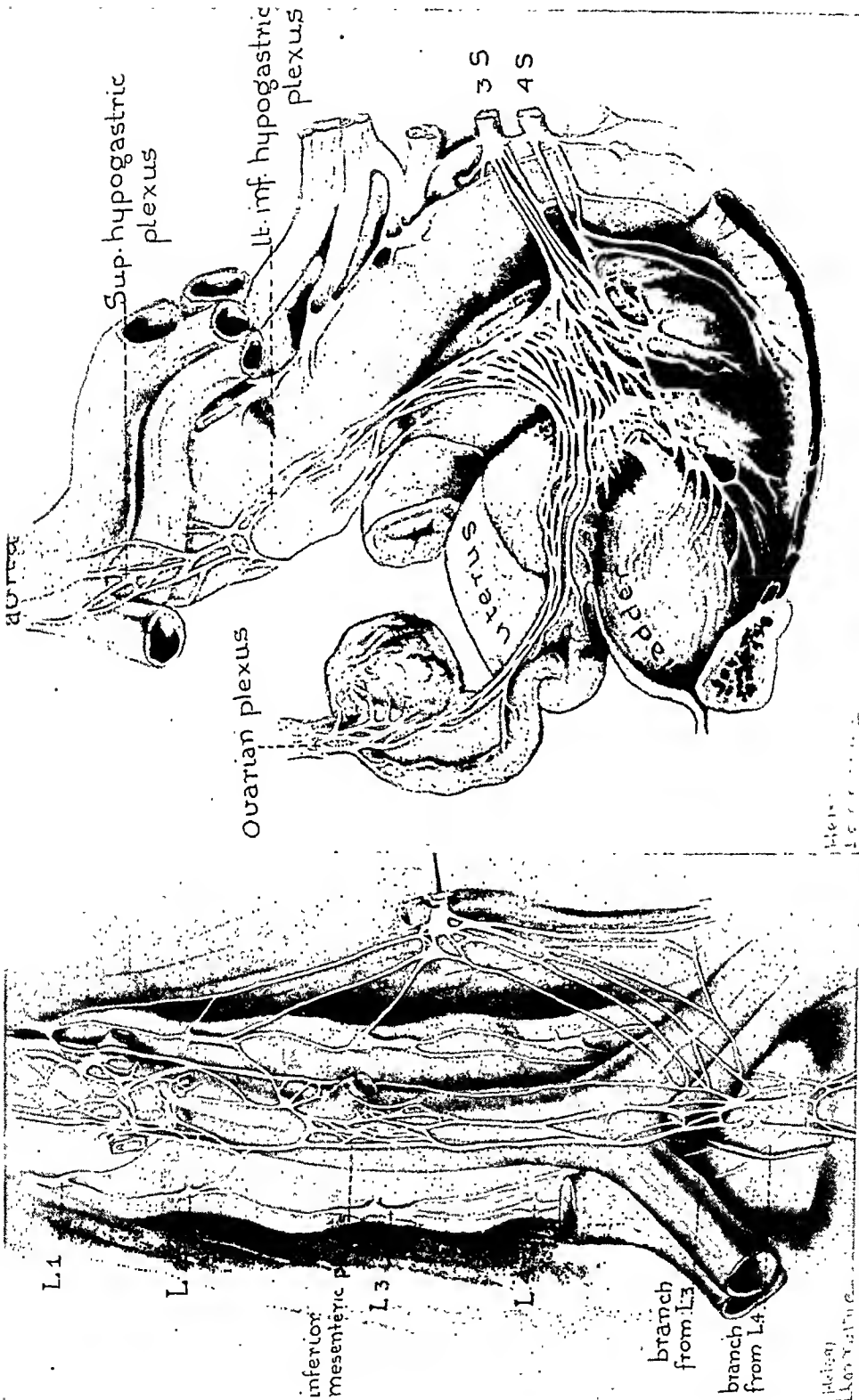


FIG. 1.—Showing the origin of the superior hypogastric plexus as a continuation of the inferior mesenteric plexus, and the important branches to it from the first, second, third and fourth lumbar ganglia.

FIG. 2.—Showing the division of the superior hypogastric plexus into its two terminal plexuses, i.e., the right and left inferior hypogastric, and the distribution of the fibers from these to the uterus, ovary and bladder. Fibers from the 3 S and 4 S will also be noted.

Important branches to this plexus come from the lumbar sympathetic chains. Delmas and Laux³⁶ found that branches come from the first and second lumbar ganglia, also from the third and fourth, and that the superior mesenteric plexus is made up in similar fashion to the splanchnic nerves and consequently these branches are often referred to as the pelvic splanchnic nerves. About one inch below the origin of the inferior mesenteric artery the superior hypogastric plexus begins. The plexus enters the pelvis over the bifurcation of the aorta, crosses the left iliac vein, passes over the sacral promontory and on down over its anterior surface. According to the studies of Elaut, also Dobrzaniecki and Serafin,³⁷ the arrangement of the plexus is quite irregular and variable, sometimes approaching a definite band and again spreading out fanwise in several branches. Generally speaking, the lower end of the superior hypogastric plexus is about on the level of the bifurcation of the common iliac artery. Segond³⁸ has shown the plexus to consist of a network of nerve fibers closely united by anastomosing branches and connective tissue. It extends from the upper part of the lumbar to the middle of the first sacral vertebrae. Elaborate histologic studies of the pelvic sympathetics and their ultimate distribution have been made by Kuntz,³⁹ also by Dahl.⁴⁰

GENERAL CONSIDERATIONS.—The pelvic sympathetic nerves are mainly afferent. They probably have to do with the regulation of the functional activities of the internal pelvic organs, and they likewise exercise some control over their vascularity and visceral sensibility. It is believed that the hypogastric plexus exerts a vasoconstrictor effect on the blood vessels of the internal genital organs and that the parasympathetics have a reverse effect. It not infrequently happens, after presacral resection, if it is done a few days before a normal menstrual period is due, that a supplementary period may intervene. However, afterward, the periods resume their routine regularity.

Fontaine and Herrmann,⁴¹ and others have expressed their belief that the hypogastric plexus carries the more important pathways of sensation from the internal genital organs to the medullary centers and that section of the superior hypogastric plexus above the hypogastric ganglion is a safe, simple and efficacious way of interrupting these pathways in the treatment of the functional type of dysmenorrhea as well as a method of relieving other forms of pelvic pain. Craig, also Douglass,⁴² have practiced resection of the presacral nerve for the relief of pain in certain cases of interstitial cystitis. Learmonth and Braasch,⁴³ also Fulcher,⁴⁴ myself, and others have resected the presacral nerve in the treatment of cord bladder with good results.

In patients in whom there are definite anatomic or pathologic lesions present which may account for part of the pelvic pain, I would not advise resection of the superior hypogastric plexus as the sole therapeutic procedure, but believe the lesions as far as possible should be corrected and that the

sympathectomy should then be done. This last is believed an important part of the operation in such cases.

Rankin⁴⁵ states that he does a resection of the superior hypogastric plexus, including the inferior mesenteric ganglia, in cases in which he does a combined abdominoperineal resection of the rectum. He believes that cases so handled are less likely to have complications involving the urinary bladder and that its emptying will be more complete.

Many remedies have from time to time been suggested for the relief of dysmenorrhea, such as hot baths, various drugs, including purgatives, sedatives—such as belladonna and codeine; minor surgical procedures such as dilatation of the cervix, correction of uterine flexions, or both. Since Novak⁴⁶ showed that the rate of blood flow during the normal menstruation does not exceed two-thirds of a drop per minute, and in view of the fact that many of these patients have cervical canals that are patulous, it is rather improbable that the caliber of the cervical canal does have much, if any, bearing on the etiology of dysmenorrhea. The woman complaining of pelvic pain and dysmenorrhea without demonstrable pathology has for many years been more or less of a bugbear to the surgical profession. While there have been a multitude of remedies in the past for this condition, all of them have been disappointing. Finally, in quite a few of these patients the ovaries or the uterus, or both, have been removed, with disastrous results.

Many theories have been formulated in regard to the ultimate cause of dysmenorrhea. The pain in this condition, I believe, generally is thought to be due to excessive contraction of the uterine muscle. Some have thought that this is due to disturbances resulting from endocrine imbalance, some to nerve imbalance, or, as Pemberton has recently suggested, arterial spasm; just which one of these, or several different factors may play a part, I believe no one can definitely say. At some time in the future, many of these cases will probably be relieved by the use of endocrines. At the present time it seems that the best thing we have to offer is surgery.

Some of the unfortunate victims of dysmenorrhea or pelvic pain have been treated as neurasthenics; doubtless the fact has been very well established that constant, nagging pain in itself may bring about a condition of nervous instability. It is probably part of a vicious circle. The greater the nervous and mental instability, the lower the threshold of pain and the less able the patient is to resist discomfort and suffering.

It has seemed that in the presacral nerve resection we have an operation that compares favorably with many of our well established, standardized surgical procedures, a remedy that does enable us in some cases to rehabilitate a certain type of patient. In this work we have attempted to apply presacral resection not only to cases of primary pain and dysmenorrhea without demonstrable pathology, but also to secondary types in which the pain followed pelvic disease, inflammatory or otherwise, likewise the intermenstrual pain or Mittelschmerz of the Germans, the neuralgic pain incidental to sclerocystic ovaries, *etc.*

It has been our belief that the pelvic lesions should be corrected as far as possible by surgical procedures and if, in the opinion of the surgeon, the removal or correction of the pathology found would not reasonably insure the patient comfort and freedom from pain, presacral resection should also be carried out. Resection of the presacral nerve has no adverse effect on either the anatomy or physiology of the pelvic organs. Cotte, Aubert,⁴⁷ and others have reported considerable numbers of normal pregnancies following this surgical procedure.

INDICATIONS.—*Dysmenorrhea*.—Cases in which no organic lesion can be found to account for the pelvic pain; persistent pelvic pain following pelvic operation; cases in which the pathologic lesion is known but is too extensive for complete removal; pelvic pain associated with anatomic or pathologic lesions, the correction of which in the opinion of the surgeon may not give the patient entire relief, and pelvic pain, the result of inoperable carcinoma of the pelvis and not associated with bony metastases or ureteral blockage. At times the operation is doubtless of some value in conditions such as dyspareunia, vaginismus and pruritus vulvae.

Kindel and others are of the opinion that the most favorable cases for presacral nerve resection are those in which the pain is a dull, deep ache in the pelvis, existing usually not only at the time of the menstrual period, but at other times as well; pain extending downward to the region of the coccyx, to the rectum, also to the inner surface of the thighs. It is also believed that in cases having pain of that type or in any one of the above mentioned locations that the results will likely be favorable.

Presacral resection may, in the opinion of Rozemon and Lambret, and others, definitely tend to regularize the menstrual function; probably favors the absorption of pelvic adhesions and tends to cause the disappearance of parametritis and inflammatory lesions in the pouch of Douglas.

OPERATION.—*Type of Operation*.—Resection of the superior hypogastric plexus in the usual manner, or resection of the superior mesenteric ganglia, or section or removal of the lower part of the lumbar sympathetic chain of one or both sides, or all three of the above mentioned procedures combined.

While the operation in the average case can be most easily accomplished through a left rectus incision extending a little above the umbilicus, it can also be very well performed through a Pfannenstiel incision; a modification of the latter approach is advantageous in case of obese patients. While a great many surgeons advise that we begin resecting the plexus above and carry the dissection of the nerve fibers downward, my personal belief is that the operation is more readily performed if the reverse method, beginning below, is used.

Dangers of Operation.—The inferior mesenteric vessels are sometimes in direct and intimate relationship with the presacral nerve, particularly when the pelvic mesocolon is implanted so as to overlap the left iliac vessels. This condition is said by Elaut to occur in about eight per cent

of cases and may make it difficult to separate the nerve fibers without injury to important blood vessels. Fibers of the plexus may at times pass outward in a long loosely mobile mesocolon rather than across the trigone, bounded by the iliac vessels. He also mentions a case in which there was a large anomalous vein which passed across the interiliac trigone and drained into the common iliac vein.

In some of our more severe cases of pelvic pain associated with dysmenorrhea, we have, in addition to resecting the presacral nerve, in some instances resected a portion of the lumbosacral cord in the region of the third and fourth lumbar ganglia.

Jianu⁴⁸ does a most extensive sympathectomy for the relief of pain from inoperable cancer of the servix, removing most of the sympathetic nerve fibers from the renal plexus down to and including the inferior hypogastric plexus. He states that all of his patients who survived the operation were completely and permanently relieved of pain.

While the usual site of pain was in the lower abdomen and back, Bernard and Theodoresco⁴⁹ reported relief of pain extending downward in the legs, and in one patient in the heel as well. The above quoted authors were unanimous in denying any permanent untoward effects from these operations. Temporary incontinence of urine and feces was observed, usually lasting for only a few days. In no case was there any impairment of either sensory or motor function of the extremities.

The following criteria have been suggested for the selection of some of the suitable cases for sympathetic resection: (1) Patients suffering from severe pain resulting from inoperable cancer of the uterine cervix; (2) the pain is intense and not improved by irradiation therapy; (3) roentgenologic examination of the pelvis reveals no evidence of bone invasion; (4) blood chemistry shows that the blood urea nitrogen is within normal limits; (5) blood and hemoglobin estimations are 50 per cent of normal or greater.

In Behney's⁵⁰ list of 22 operative cases for the relief of pain incidental to inoperable uterine cancer, he found that the pain was relieved in 72 per cent. However, he believes that the failures in some cases were due to technical difficulties which prevented a complete and radical type of operation. Greenhill and Schmitz⁵¹ have likewise reported a number of excellent results in such cases.

RESULTS.—A total of 85 presacral neurectomies have been done by us; all except seven of these have been done in one hospital, the Charleston General Hospital by myself and surgical associates, Drs. Hugh A. Bailey and W. L. Cooke. These cases have been followed up closely and checked carefully, both before operation for definite indications and since, for results. We are unable to trace one of the patients; six of the above number have undergone operation too recently to be included in this report. This leaves a total of 78, on which we have been able to secure a detailed follow up.

Naturally, the most favorable results have been with the primary type

of dysmenorrhea. Among the first apparently successful cases there have been a few recurrences, two of the recurrent cases have been reoperated on and in each case we have found that neuromata had formed on the cut ends of some of the nerve fibers. It is believed that this may have accounted for the recurrence of the pain. Other failures may have been due to incomplete operations, possibly an abnormal distribution of nerve fibers at times plays a part. Doubtless some of our failures have been due to improper selection of cases.

Many of our cases have been of the severer types, some of them having nausea and vomiting with severe pain radiating down the thighs at the time of the menses, many of them having to spend several days in bed and requiring hypodermics of morphine. A number of these patients have stated that the operation has given them a degree of comfort that they had hitherto not known or imagined, and a new outlook on life.

It must be borne in mind that in recording results after operations, in some cases at least, the apparent failure to give the patient lasting relief is due to the result of intercurrent infections, such as tubo-ovarian inflammation of venereal origin. We found this to be the case with two of our patients who had reported recurrence of pain after leaving the hospital, both of them having developed pus tubes subsequent to presacral operation.

As Craig⁵² has pointed out, there will probably always be as much as 10 per cent of poor results in cases of dysmenorrhea, due to the border line type of case, some of them being the victims of a constitutional biologic inferiority.

Fifty-nine cases have been operated on between six months and two and one-half years. Twenty-five cases within the past six months. Results about the same. Eighty-five cases have been operated on altogether. One has not been heard of since operation. Six have undergone operation too recently to report.

Two patients died: one patient died of peritonitis of unknown cause, probably due to some infection introduced at the time of the operation. At postmortem the peritonitis was found to be apparently general and its origin could not be found; the incision in the parietal peritoneum was perfectly healed. The second patient had an inoperable cancer of the cervix, and died of acute cardiac failure the following day.

Two of the patients who had recurrence of pain following operation were reoperated on without improvement.

One patient, following operation two years ago, is now six months pregnant.

Seventy-one of the cases selected for this operation were taken from a total of 2,433 gynecologic cases examined at the Charleston General Hospital Clinic (Table I).

The following typical case histories are appended in order to give a general idea of the class of patients upon whom operation was undertaken:

TABLE I
RÉSUMÉ OF 78 CASES OF PRESACRAL SYMPATHECTOMY

	No. of Cases	Im- proved	Unim- proved	Com- plete Relief	Deaths	Per- centage Im- proved	Mortal- ity, Per- centage
Pelvic pain.....	33	7	4	21	1	84	.03
Dysmenorrhea and pelvic pain.....	11	5	1	5	0	90	
Dysmenorrhea.....	21	5	3	13	0	85+	
Pelvic pain and constipa- tion.....	3	1		2	0	100	
Dyspareunia and pelvic pain.....	4	2	1	1	0	75	
Pelvic pain following ab- dominal operation.....	4		2	2	0	50	
Inoperable cancer.....	2			1	1	100	.05
Totals.....	78	20	11	45	2	83+	.02%

OPERATIVE PROCEDURE

Presacral nerve resections alone.....	41	11	6	23	1	82	.02
Presacral nerve and addi- tional operations.....	19	6	1	12	0	91	
Presacral nerve and lumbar ganglionectomy.....	12	3	2	6	1	75	.08
Presacral nerve, lumbar ganglionectomy and ad- ditional operation.....	6		2	4	0	55	
Totals.....	78	20	11	45	2	83+	.02%

ILLUSTRATIVE CASE REPORTS

Case 1.—Mrs. N. P. F., No. 44985, aged 31, admitted to the Charleston General Hospital, May 8, 1935, complaining of pelvic pain for several years, which is worse during her menses; has a constant feeling of soreness and aching about the pelvis; is subject to headaches and feels quite miserable most of the time.

Operation, June 9, 1935.—There were a few fibrous adhesions on the posterior surface of the uterus. The uterus was otherwise normal in appearance and size, relatively speaking. The appendix had been previously removed, ovaries, tubes and gall-bladder apparently negative, relaxed perineal outlet. Procedure: Resection of the fundus of the uterus, resection of the presacral nerve, cauterization of the cervix and perineorrhaphy.

The patient made an uneventful postoperative recovery and was discharged June 1, in good condition. Three months later she wrote: "My operation has given me complete relief from the pain from which I suffered before. I feel so much like a new person that I haven't words to express how grateful I am."

Case 2.—Miss S., No. 40673, aged 19, admitted to the Charleston General Hospital, June 8, 1934, complaining of severe pelvic pain at her menstrual periods, especially

during the first few days when she had to go to bed. She routinely spent from three days to a week in bed at each period, was violently nauseated, had severe pains running down the inner surface of both thighs. Had previously had a dilatation of the cervix without effect.

Operation, June 9, 1935.—The pelvic organs were found to be apparently negative in all respects. The appendix was removed and presacral nerve resection was performed.

Following the operation the patient made an uneventful recovery, and during her stay in the hospital menstruated once without pain. She was discharged June 23, in good condition, has returned several times at our request for observation and states that she has experienced complete relief from her previous dysmenorrhea.

Case 3.—Mrs. A. L. R., No. 45347, aged 37, admitted to the Charleston General Hospital June 2, 1935. She states that since the birth of her child, seven years ago, she has had a bearing down sensation and dull ache in the pelvis, had a suspension of the uterus and perineorrhaphy five years ago, has very painful monthly periods, frequency of urination at times, and a sensation of pressure in the bottom of the pelvis.

Operation, June 3, 1935.—Uterus bound down by adhesions in position of ante flexion; gallbladder, appendix, tubes and ovaries normal. Uterus normal size. Procedure: The cervix was cauterized, subtotal hysterectomy, appendectomy and presacral nerve resection.

The patient made an uneventful recovery and left the hospital on June 20, 1935. She wrote two months later that she was completely and entirely relieved of the pelvic ache and bearing down sensations, and is comfortable for the first time since the birth of her child.

Case 4.—Miss E. R., No. 45674, white, aged 18 years, admitted to the Charleston General Hospital June 24, 1935, complaining of deep nagging pain in the right lower quadrant of abdomen, and soreness in the left lower quadrant.

The patient states that she has frequent sharp pains in the right lower abdomen, since she was operated on for appendicitis, in August, 1934; that she has nausea associated with the pains but never vomits. Is constipated, menstrual periods are regular and normal, except for severe cramping pain.

Operation.—Incision through the old scar line, this being completely excised. The cecum was adherent near the under surface of the incision which had been made for removal of the appendix, but there were no adhesions between the small bowel and incision. Exploration of the abdomen revealed no other pathology. The adhesions between the cecum and anterior parietal peritoneum were not disturbed.

Presacral nerve resection, including the nerve fibers from the promontory of the sacrum up to, and around, the origin of the inferior mesenteric artery; the right lumbosacral cord was divided.

The patient left the hospital on July 12, 1935, in good condition. On September 18, 1935, her doctor reports that "She seems to have made a satisfactory recovery and has secured complete relief."

Case 5.—Miss S. K., No. 38537, colored, aged 18, high school student, admitted to the Charleston General Hospital, April 8, 1934, complaining of severe cramping pain in the lower abdomen incidental to the onset of each menstrual period. She states that she began menstruating at 12 years of age and that all of her periods since have been accompanied by severe and excruciating pain; that she is usually in bed for several days at the time of her monthly periods.

Operation.—Pelvic organs and appendix apparently negative. Resection of the presacral nerve and appendectomy. The patient made an uneventful recovery and left the hospital on the twelfth postoperative day. On June 6, 1934, she reported complete relief from the pelvic pain at her monthly periods. However, in September, 1935, she stated that she had gotten married a few months previous and since that time had some recurrence of pelvic pain. Examination revealed an adherent mass on the left side of the pelvis, apparently the result of tubo-ovarian infection.

COMMENT.—Our cases have been selected with a good deal of care and operation has been advised only in those patients in whom the symptoms have lasted for a long time, and which have resisted adequate medical treatment. We have tried to select them in a way that would enable us to properly evaluate the value of the operation. For instance, when any urinary tract pathology was suspected the case has undergone a careful urologic examination.

As before indicated, in selecting cases, we have considered only those in which the pain has existed in the same location over a period of years rather than for a few weeks or months, or those patients in whom a routine severe dysmenorrhea has existed over a period of years and which medical treatment has failed to relieve. We are not proposing the method in any sense as a cure-all but do believe that it has a definite place in the relief of a certain class of patient. I am convinced that it has enabled us to relieve a number of these unfortunates and in some cases, at least, to make them useful members of society again.

SUMMARY.—It is believed that the results obtained by the operation of presacral nerve resection for the relief of dysmenorrhea and pelvic pain compare favorably with those obtained by many of the standard surgical procedures. The method is not put forward in any sense as a panacea.

It is apparently of more value in the treatment of primary than of secondary dysmenorrhea.

It is of great value in the relief of pelvic pain, whether the cause is of undetermined origin, sclerocystic disease of the ovaries, the result of inflammatory disease, or pain due to inoperable uterine cancer. However, every available means of relief should be tried before resorting to operation.

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DISCUSSION OF PAPERS OF DOCTORS BLACK AND CANNADAY

DR. EMIL NOVAK (Baltimore, Md.).—There is no gynecologic problem which constitutes such an efficient test of the gynecologist's knowledge, his thoroughness, and the breadth of his scope, as the management of primary dysmenorrhea. Its causes are varied, and the treatment must be varied also. Many cases can be relieved by constitutional upbuilding, not a few by psychotherapy, and some by organotherapy. But there is a small residue of cases which are intractable to even the most comprehensive plan of treatment, so that even hysterectomy has to be considered. As a matter of fact, there are some surgeons who have resorted to this very radical procedure many times, even in young women.

It is in this intractable and very severe type of dysmenorrhea that presacral sympathectomy must be welcomed as a valuable addition to our therapeutic armamentarium. But I repeat that, if other more conservative measures are conscientiously carried out by both patient and physician, this group should not be large, so that no one surgeon should have any considerable number of cases of this operative procedure to report during any one year.

I have performed the operation in only a few selected cases of the aggravated type, and thus far have been pleased with my results. The operation may be fairly said to be a simple one. In picking up the fibers of the plexus, I have found the tenaculum a useful instrument. As some of the fibers are often found behind the left iliac vein, this vessel must at times be drawn aside to get at them.

In spite of the fact that we now have available reports of many of these operations, it is still too early to evaluate it very accurately. Since dysmenorrhea is a subjective disorder, the psychic factor in its causation, and also in its cure, is difficult to eliminate. The procedure can often be usefully combined with other pelvic operations. For example, if a dysmenorrheic patient has a sharp retroflexion, it is often impossible to be sure how much the displacement has to do with the menstrual pain. In such cases it is often a good plan to combine a presacral sympathectomy with the suspension operation, even though such combined operations may make it impossible to tell which contributes most to the relief of the patient.

It is obvious that the operation will lend itself very readily to abuse, if gynecologists come to look upon it as a short cut to successful treatment, without the necessity of thorough study of the individual case and without the trial of more conservative measures.

DR. JOE V. MEIGS (Boston, Mass.).—Dr. J. C. White and I have tried to work out the value of this operation for dysmenorrhea. We have done no other surgery upon the patients, such as dilatations, salpingectomies, suspensions, *etc.* In a group of 15 cases, the first 12 had a perfect result, but the last three have about the same amount of pain as before the operation. It is possible that our neurectomy was not extensive enough or that some fibers were left untouched. We feel that the operation is of extreme

value, but that it cannot be hurried through, and that the dissection must be complete. Whereas I felt we could always guarantee a cure, lately I have felt less positive.

DR. GUY L. HUNNER (Baltimore, Md.).—In spite of the rapidly increasing literature favoring the operation of presacral sympathectomy for the control of pelvic pain, I have not as yet made use of this newer procedure. When we hear such convincing papers by men of such known conservative tendencies as Doctors Black and Cannaday, we must conclude that we may have been missing opportunities for helping certain patients, who can be relieved in no other way.

While I cannot discuss this operation from the viewpoint of personal experience, I do wish to offer what I think may be a helpful suggestion from the viewpoint of diagnosis and the selection of cases in real need of the operation.

It is not generally known that ureteral stricture is one of the common causes of dysmenorrhea. Doctor Cannaday, in discussing his indications, states that "It must be known that the pain is not due to ureteral blockage or to malignant metastases, otherwise no benefit could be expected," and later he observes, "When there is the least suspicion of urinary tract pathology, the case has undergone a careful urologic examination." I know from a considerable experience with patients referred because of dysmenorrhea, which resists all the usual remedies, that not all diagnosticians have reached the advanced stage where they keep in mind the possibilities of genital tract symptoms being due to disease of the urinary tract. There is no mystery concerned, and no difficulty, in differentiating most patients suffering with ureteral dysmenorrhea. Many of them are diagnosed with a reasonable degree of certainty on the history alone. In some the history is only slightly suggestive, or perhaps gives no clue pointing to a urinary tract origin of the pain, and the diagnostician gets his first clue when making the routine physical examination. In a few the anamnesis and physical examination may both leave one in serious doubt, and then special urologic methods have to be used.

First, what are some of the suggestive points in the patient's history? I have learned to suspect ureteral dysmenorrhea if, in answer to the first question as to the patient's complaint, she places her finger tips over the region of Poupart's ligament, and says, "I have pain in my ovaries at the monthly period." This at once suggests the possibility that the pain may not be of uterine origin. Further questioning often reveals that this pain begins a few days or even a week before the flow begins. In other words, it seems that the premenstrual congestion further narrows the ureteral lumen, causing greater muscular activity and consequent pain in the tender stricture areas.

We have not time to elaborate on the great variety of collateral symptoms that may be present in any patient subject to renal stasis. We simply need recall the classic picture of ureteral stone, for stricture by itself can duplicate every symptom associated with stone.

The history may show that during most of the time the patient is subject to any one, or to combinations, of these symptoms, but they are so exaggerated in the premenstrual and menstrual epoch as to convince the uninitiated that they must be of genital tract origin.

The ureteral dysmenorrhea may have been present from the onset of menstrual activities, for stricture occurs frequently in the young. A dysmen-

orrhea coming on after several years of painless periods, and in the absence of evident pathology in the genital tract, may be of ureteral origin.

A dysmenorrhea which is not cured by childbearing and is not accompanied by evident pathology in the genital tract is likely to be of ureteral origin. Not infrequently the history of dysmenorrhea begins soon after a childbirth, and in the absence of evident genital tract cause, one should think of the ureters; for latent or quiescent stricture is often stirred into the active production of symptoms, after the trauma of childbirth, operation, or a severe accident. Second, if the dysmenorrhea is of ureteral origin, what do we find on making the routine physical examination? The kidneys if palpable are often tender. If they are not palpable there is sometimes complaint of tenderness in the attempt to palpate them. On palpation over the ureters at the pelvic brim crossing usually there is tenderness and this sometimes is referred to the bladder. On palpation of the ureters in the juxtavesical or broad ligament regions, they are tender, and the patient often exclaims, "That is my menstrual pain." Doctor Cannaday has quoted Cotté as advising the presacral sympathectomy for dyspareunia. I find that the most common cause of dyspareunia that is located deep within the pelvis is ureteral stricture. If bimanual pelvic examination reveals gross pathology, such as uterine tumor, ovarian cyst, pelvic inflammatory disease, or malposition of the internal genitalia, and if we have already found the above evidences of ureteral stricture, we should be very careful in our prognosis as to what the proposed operation will do toward relieving the patient's symptoms. Many women have had their pelvic organs removed because of symptoms arising chiefly in the urinary tract. Of course, the dysmenorrhea is relieved but the collateral symptoms often continue to keep the patient a semi-invalid. Third, in case the history and physical examination suggest the ureteral cause of dysmenorrhea, what do we learn by special urologic methods? By the bulb test we easily determine whether there is organic narrowing of the ureteral lumen, and if stricture is present we reproduce the patient's menstrual pain. Most valuable and most convincing is the relief by simple urologic methods of symptoms which have defied all of our usual therapeutic measures.

DR. W. F. SHALLENBERGER (Atlanta, Ga.).—My experience with this procedure is limited to six cases. One was a patient suffering from pain due to recurrent carcinoma of the cervix in which the results were only fair. In another instance, in the course of a pelvic operation at which I did a hysterectomy and excised large varicosities from the broad ligaments, I also did a presacral nerve resection hoping to relieve a dyspareunia. There was practically no benefit derived from this procedure. In four patients the operation was performed for so called essential dysmenorrhea. These operations were all done in young women, one of whom had had two previous abdominal operations and had had a stem pessary inserted without any relief. In fact, she seemed to be getting worse. The urinary tract had been investigated and was ruled out as a cause of the pain. The girl was desperate and almost on the verge of suicide and had begged me to do a hysterectomy; I decided, however, to try a nerve resection, which I did about 18 months ago. The results so far have been satisfactory. In the remaining three patients the results have been perfect.

DR. HENRY D. FURNISS (New York, N. Y.).—I have performed this operation six times. Three cases of Hunner ulcer, with temporary relief in one, and satisfactory results in the other two; as one of these two had fulgura-

tion of the ulcer, and the other a partial excision of the bladder, it is difficult to say how much credit should be given to the sympathectomy. One patient with retroversion suffered with severe dysmenorrhea; she was completely relieved after a round ligament shortening and a sympathectomy. Beginning four days after operation she had slight incontinence of urine for nearly a week. A fifth patient, one with dysmenorrhea, besides the nerve resection, had an endometrioma of the left ovary removed. She was relieved of her pain. The sixth case had an inoperable carcinoma of the bladder; the ureters were implanted in the inguinal region, and a sympathectomy performed; the secretion from the bladder growth caused bladder pain when she had to evacuate it—about every four hours. A vesicovaginal fistula was made with the cutting current, following which she was relieved fully 90 per cent.

As more than the sympathectomy was done in all of these cases, it is difficult to determine to just what degree credit is to be given it.

DR. WILLIAM T. BLACK (closing).—I agree that these cases should be very carefully studied, for the operation may be abused and do a great deal of harm. I neglected to mention that two of these patients had symptoms of slow voiding after the operation: one for two months and one for three, but they cleared up and they have remained normal. It is not necessary to catheterize in these cases oftener than after other abdominal operations. My results have been very favorable, and the most appreciative patients I have had for some time have been those in whom a neurectomy was performed.

DR. JOHN E. CANNADAY (closing).—I agree with Doctor Novak that the operation should be done in a way to enable us to properly evaluate the method, and it should never be done without previous recourse to all known means of relieving the patient otherwise. In the cases in which we have operated, the patients in most instances had been suffering for years. We have not employed it for patients who have suffered only a few months, but only in those cases that we felt could not be relieved by any other available means. We have not noted any undue incidence of catheterization after these operations; I am sure this has happened no more frequently than in other cases. I did not intend to convey, and do not feel, that this operation is in any sense a panacea, but I think it stands with other standard procedures. One group in which we have used it is one in which we will not be able to absolutely determine which procedure has given relief, but I believe in justice to the patients if they have a pelvic operation for other conditions, especially for minor disorders; unless the surgeon is certain, in his own mind, that the anatomico-pathologic corrections will relieve the patient's symptoms, he should, in addition, perform a presacral nerve resection. I cannot believe it does any harm, and if anything can be done to help insure permanent relief for these patients I think it should be done.

PRESACRAL SYMPATHECTOMY FOR DYSMENORRHEA AND PELVIC PAIN

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A RESECTION of the presacral (hypogastric) nerve for the relief of dysmenorrhea and pelvic pain has given excellent results in the majority of the 24 cases herewith reported. The reports from foreign, as well as American literature, are most favorable.

Cotté, in 1924, first performed presacral sympathectomy, and Jaboulay, Ruggi and Leriche were among the first to report good results from this procedure. The surgical technic generally used by foreign gynecologists has been adopted in this country only during the last three or four years. A consideration of this subject by American surgeons may be found in the contributions of Adson and Masson,¹ Counsellor and Craig³ DeCourcy,⁴ Wetherell,¹⁵ Greenhill,⁸ Pemberton¹³ and Keene.⁹ Behney² and Schmitz have written about the relief of pain in cancer resulting from sympathectomy. A knowledge of the anatomy and physiology of the presacral nerve is essential for the proper interpretation of the results obtained, as well as in the performance of the operative technic. Langley designates the nervous system controlling the visceral functions, the involuntary muscles and ductless glandular system as the autonomic, or vegetative nervous system. The sympathetic and parasympathetic nerves compose this system. The presacral nerve is a sympathetic nerve, derived from the inferior mesenteric ganglia anastomosing with the lumbar ganglia. (Nerve fibers may come from the renal ganglia also.) It is prelumbar in location and is found in the triangle produced by the common iliac arteries and a transverse line passing over the promontory of the sacrum. In thin individuals, especially if a single nerve exists, it may be visualized lying behind the pelvic peritoneum. According to Elaut,⁵ in one-third of the cases it is to the left of the median line.

The presacral nerve is a single nerve in from 15 to 20 per cent of patients. Elaut found this condition existing in 24 per cent of his cases; Delmas and Laux, in 20; and Ferey, in 15 per cent. Therefore, as Latarjet states, "It should be better called a plexiform nerve, as described by Havelacque."

In a small percentage of cases a wing of the mesocolon is attached to the right, and it is necessary to dissect and push the colon to the left before the nerve can be approached. This occurred but once in the 27 cases reported.

The presacral nerve, after passing the promontory, divides into the right and left inferior hypogastric nerves. They then pass posteriorly to the rectal fossae and terminate in Frankenhäuser's ganglia (hypogastric ganglia) and

here receive anastomotic fibers from the second, third and fourth sacral, or parasympathetic system. They then pass to the uterus, bladder, rectum and vagina.

The presacral nerve causes a vasoconstriction of the blood vessels and lessens secretion, antagonizing the parasympathetics, which are vasodilators (Learmonth¹²). Its severance produces muscular relaxation. Uterine post-operative bleeding in two or three days verifies the fact that severing the presacral nerve causes a vasodilator effect, which permits the parasympathetic nerves to dilate the blood vessels. This is particularly noticeable, if the patient is operated upon immediately following menstruation. It has been suggested by Pemberton¹³ that sclerocystic ovaries may be due to an abnormal blood supply caused by an imbalance in the autonomic nervous system.

Just why presacral sympathectomy relieves pain is conjectural, as various writers have different views regarding its physiology. Pelham and Amreich¹⁴ state that the sympathetics have only efferent fibers. The relief of pain after a sympathectomy is an established fact, and can best be explained by the interrupting of the nervous impulses from the organs supplied by this nerve to the medullary centers (Fontaine and Herrmann⁶) or to the cord (Gask and Ross⁷). The emotional effects upon menstruation and the visceral nervous system favor the medulla as being the regulatory autonomic mechanism involved.

According to Livingston and Kuntz¹¹ the presacral nerve also contains afferent fibers. That it is a sensory nerve is apparent from the relief of pain when the nerve is severed. The parasympathetic nerves have both efferent and afferent fibers. It is also evident that the presacral sympathetic nerve not only conveys impulses to, but from, the viscera supplied by it.

It has been shown by Rein and Calliburce that severing all extrinsic nerves of the uterus does not interfere with uterine contractions. Cotté reports 30 cases and Wetherell¹⁵ one case, in which a presacral sympathectomy did not affect uterine contractions during parturition.

Indications for Sympathectomy.—Presacral sympathectomy probably serves its most useful purpose in essential dysmenorrhea in the young woman. It should not be indiscriminately performed. Other remedial agents should be tried first, *e.g.*, hygiene, proper diet, exercise, uterine dilatation, endocrine therapy, *etc.* If these measures are futile, then a sympathectomy may be performed. There is certainly no place in gynecology today, in the treatment of essential dysmenorrhea, where one is justified in performing a hysterectomy, or using castrating doses of irradiation.

A sympathectomy is also indicated in those who have persistent pelvic pain, with pelvic pathology. A dilatation of the uterus and the correction of retrodisplacements will relieve about 65 per cent of cases of essential dysmenorrhea: by performing a sympathectomy on the remainder, nearly 100 per cent will be cured. In incurable pelvic carcinoma it also gives good results, but alcohol injected into the spinal canal is also meeting with much success. One should not expect presacral sympathectomy to relieve backache

PRESACRAL SYMPATHECTOMY

as the pathology is entirely independent of the area supplied by this nerve. The ovaries are supplied by the ovarian plexus, which originates in the aortic, celiac and renal ganglia. Therefore, ovarian pain can be relieved only by severing the ovarian plexus. In an intractable bladder condition, the result from a sympathectomy of the presacral nerve is excellent. Cases of pruritis vulvae and constipation have been reported as being relieved by this operative procedure. The

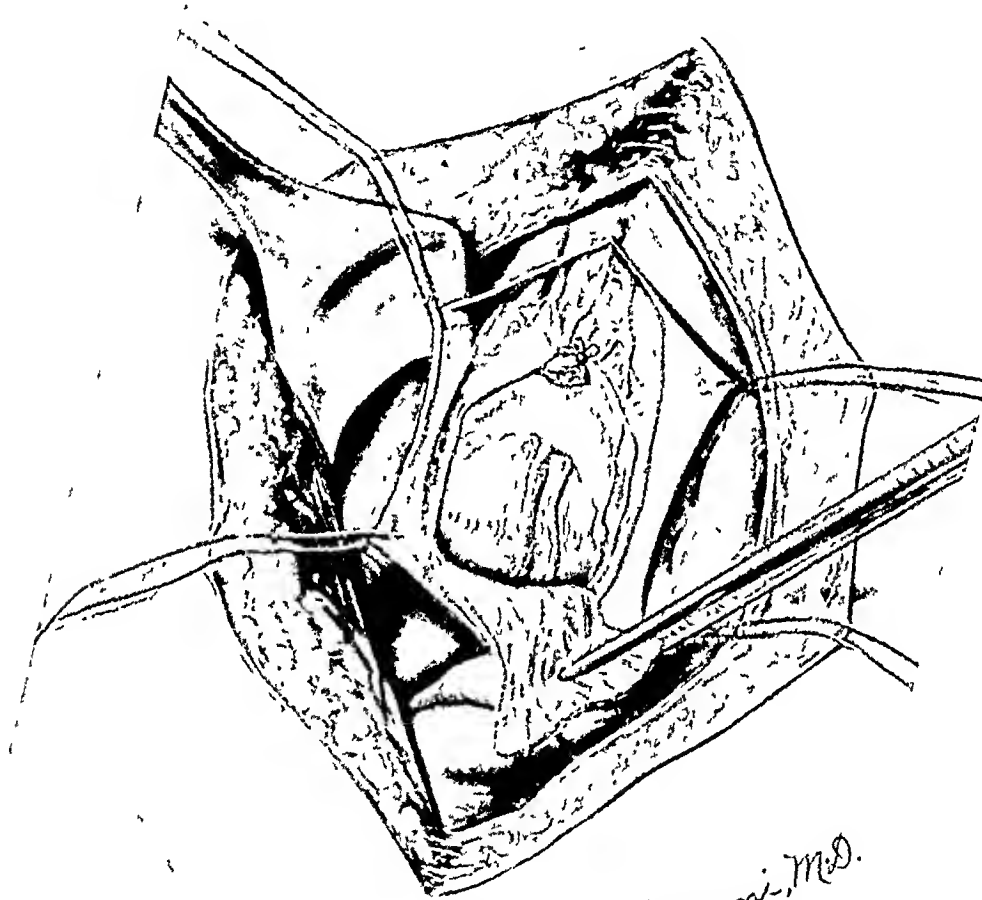


FIG. 1.—Operative technic showing sutures retracting peritoneum, nerve resection (tied at upper end) and structures in interiliac triangle.

author has had two cases of dyspareunia relieved by this operation. It has been conclusively proven that a resection of the presacral nerve does not interfere with menstruation, libido or parturition.

Operation.—A median incision extending from the pubic region up to the umbilicus is best suited for a presacral sympathectomy. With the patient in a Trendelenburg position and with the intestines well packed cephalwards and laterally, the presacral nerve region is rendered easy of access. If the mesocolon extends across to the right, it becomes necessary to dissect it from its attachment and displace it to the left.

A median incision is made through the posterior peritoneum about two and one-half inches in length. It should commence at the bifurcation of the aorta and extend downward. The cut edges are then caught with long sutures which extend out of the abdominal cavity, obviating the use of forceps, the handles of which obstruct the field of operation.

In four of the author's cases it was necessary to ligate local blood vessels. These are usually found at the lower end of the incision, but may be at the upper end. The presacral nerve, or plexus, is found just behind the peritoneum (never attached to it) in the areolar tissue. It is carefully dissected loose, and excised from the bifurcation of the aorta to the promontory of the sacrum. The remaining ends are ligated. The peritoneum is closed with plain catgut.

Posterior to the nerve are the middle sacral vessels, which vary in size and are in danger of being traumatized. In one of the author's cases the vessel was as large as a lead pencil and in two others there were cavernous-appearing sinuses.

In the plexiform arrangement careful cutting of fibers, near the iliac vessel on the left and the ureter on the right side, must be performed. Doubtless, good or poor results depend upon an abnormal distribution of nerve fibers, or their incomplete excision. When a single nerve is present and it is completely removed, good results may be anticipated.

The following cases will serve to illustrate the beneficial effects obtained from presacral sympathectomy.

ILLUSTRATIVE CASE REPORTS

Case 1.—Married six years, white, 30 years of age, para 5. Complained of dysmenorrhea since puberty, becoming progressively worse. Had pelvic pain, leukorrhea, dysuria and backache. Operated upon September 24, 1934. Perineorrhaphy, appendectomy and sympathectomy were performed. Stigmata of a previous pelvic infection was noted, but had cleared up sufficiently so that it was not necessary to remove any of her organs. She has been free of symptoms for over a year.

Case 2.—A young white woman, school teacher, 25 years of age (virgin). Has suffered all of her menstrual life from dysmenorrhea. For the past several months dysuria was also a prominent symptom. Has lost weight and for some time has suffered from insomnia, backache and nervousness. She was about to lose her position, as it was necessary for her to stay in bed three days each month and take opiates for the relief of pain.

Her uterus was retrodisplaced, which was corrected by a Barrett type of operation. A prophylactic appendectomy and a presacral sympathectomy were performed. After five days she voided regularly and has been free of her bladder symptoms and dysmenorrhea. For three months she was slow in beginning to void, but for the past several months is normal. She has gained in weight, overcome her nervous symptoms and feels better than she has at any time during her menstrual life.

Case 7.—A married woman, white, para 1. This patient was examined by the author ten days before operation. She was found to have an acquired type of dysmenorrhea and menorrhagia, which were becoming progressively worse. She had a chronic endocervicitis, and nodular masses in her pelvis. She was advised of the probability of endometriosis and was asked to return for operation when she commenced to menstruate. At operation the pelvis was found to be filled with bleeding endometrial tissue.

The right tube, ovary and as much endometrial tissue as possible were removed. The left ovary and tube were allowed to remain, due to the patient's age.

Since the operation she has been relieved of dysmenorrhea, pelvic pain and metrorrhagia. Whether the endometrial tissue will continue to proliferate and necessitate the removal of the left ovary, is problematical.

Case 17.—Married, colored girl, 17 years of age. Had one miscarriage, 16 months ago. Menorrhagia for past five months. Dysmenorrhea since puberty; confined to bed each month. Pain several days before and during flow. Since suspending her uterus and performing a sympathectomy she has been entirely relieved. A prophylactic appendectomy was also performed.

DISCUSSION.—Fifteen were white and 12 cases were colored. Three were single and 24 married. The youngest was 17 years of age and the oldest was 41.

There were nine cases of the essential and 18 of the acquired type of dysmenorrhea. Fifteen cases suffered from bladder disturbances (dysuria was severe in some and milder in character in others).

There was definite pathology in ten cases. In 14 retrodisplacements were corrected, appendectomy and sympathectomy were performed. Three had a diagnostic D. and C. and two a cauterization of the cervix, besides the sympathectomy.

In 13 cases it was necessary to catheterize postoperatively: *viz.*, four, one day; six, two days; one, three days; one, five days; and one, six days. Seven of this group had postoperative bleeding in two or three days (without pain in six, slight in one). Three cases had a single nerve, one a double nerve, and the remainder presented a plexiform arrangement. Seventeen of the operations were performed by the author, and the remaining ten by members of the visiting staff.

Excellent results were obtained in 21 cases. A marked improvement was obtained in five cases. One patient could not be located. It is needless to state that a certain percentage of these cases would have been relieved by the correction of retrodisplacements and from the removal of pelvic pathology. However, one cannot deny that the number of those relieved was greatly increased by the sympathectomy.

FOLLOW UP HISTORY.—Dysmenorrhea was practically 100 per cent relieved. Bladder symptoms were immediately relieved, but after a few months some complained of a burning upon urination. This could be due to a recent neisserian infection, although one must consider the nerve supply to the urethra as a possible cause of continued complaint. The perineal and ilio-inguinal nerves supply the urethra.

Constipation was not relieved in a number of instances; however, in some it was corrected. The relief of constipation depends upon the etiology in some cases, but the sympathetic nerve supply is so variable that failure can, in some, be ascribed to this cause.

Metrorrhagia was relieved in two cases, but emphasis was not placed upon this symptom in obtaining histories; therefore no positive statement can be made. Besides, the removal of pathology may be ascribed as a cause

TABLE I
RÉSUMÉ OF TWENTY-SEVEN CASES OF PRESACRAL SYMPATHECTOMY

No.	Race	M.	Age	Para	Menstrual History	Symptoms	Operation	Postoperative Symptoms	Results
1	W.	M.	30	5	Dysmenorrhea, in bed 2 days	Pelvic pain, leukorrhea, dysmenorrhea, dysuria, backache, previous pelvic inflammation	9/25/34 App. perineorrhaphy. Presacral resection	No pain or bladder symptoms since operation	Good
2	W.	V.	25	None	Dysmenorrhea, in bed 3 days. Opiates. 12 x 28 x 7 Essential dysmenorrhea since puberty	Dysmenorrhea, dysuria, backache, 4 mos., nervous, lost weight	1/6/35 Sus. uterus. App. presacral resection	Cath. 5 days. Relieved of dysmenorrhea and bladder symptoms. Slight menses 4 or 5 days postoperative	Good 3 or 4 mos. Slight delay in voiding
3	W.	V.	23	None	16 x 28 x 4 Clots. Dysmenorrhea always progressively worse	Dysmenorrhea, opiates 2 or 3 days, nervous, dysuria, backache	3/18/35 Sus. uterus. Sub-acute app. sympathectomy	Voided same day—relieved of pain	Good
4	W.	M.	29	1 misc. yrs. ago	Regular dysmenorrhea always	Dysmenorrhea, pelvic pain, leukorrhea, nervous, sterility	Rt. salp.-D. and C.-caut. cerv.-app. sympathectomy	Cath. 6 days. Symptoms relieved, bleeding third day	Good
5	W.	M.	24	One 3 yrs. old	13 x 28 x 8 Dysmenorrhea 2 days, menorrhagia	Dysmenorrhea, leukorrhea, frigid, dysuria, nervous, backache	7/30/35 D. and C. caut. cerv. sympathectomy	Voided—relieved dysmenorrhea, dyspareunia, nervousness	Good

PRESACRAL SYMPATHECTOMY

6	W.	M.	31	None	14 x 28 x 3 Dysmenorrhea 2 days, in bed, men- orrhagia past few mos.	Sterility, backache, low pelvic pain, constipated, loss of weight	8/10/35 Sus. uterus, sym- pathectomy, app.	Uterine bleeding 2 days postoperative, relieved of pain	Good
7	W.	M.	33	One	16 x 28 x 6 Acquired dysmen- orrhea, menor- rhagia past 2 or 3 yrs.	Pelvic pain, opi- ates for dysmenor- rhea, backache	8/23/35 Diagnostic D. and C., repair, caut. cerv., sus. uterus, right salp.-ooph. for endometriosis, sym- pathectomy	Relieved. Bleeding on third day	Good
8	W.	M.	25	4, misc.	14 x 28 x 5 Dysmenorrhea 2 yrs. 4-5 days in bed	Dysuria, dysmen- orrhea, backache	8/29/35 Sympathectomy	Cath. 2 days post- operative. 3 days uterine bleeding 2 days. Some pain, not as bad as usual	Good. Past menses no pain
9	W.	W.	31	2, one misc.	13 x 25 x 5 Dysmenorrhea 6 yrs., in bed 4-5 days, pain starts 4-5 days before menstruation	Dysuria, heavy feeling in pelvis, dysmenorrhea	8/6/35 Sympathectomy- app. pro.	Voided on after- noon of operative day	Discomfort first day, good
10	W.	M.	32	3	12 x 28 x 4-5 Dysmenorrhea	Dysmenorrhea, pelvic pain	12/3/34 Caut. cerv. bil. salp. right ooph.- app. sympathec- tomy-sus. uterus	Voided, symptoms greatly improved	Symptoms im- proved
11	B.	M.	21	One, 1 misc.	Sepsis 3 yrs. ago, dysmenorrhea, fre- quent burning uri- nation	Backache 4 yrs., leukorrhea, dys- menorrhea, consti- pated	5/1/35 D. and C., sus. uterus, app., sym- pathectomy	Cath. 2 days reg., constipation, dys- menorrhea, dysu- ria relieved	Good

TABLE I (Continued)

No.	Race	M.	Age	Para	Menstrual History	Symptoms	Operation	Postoperative Symptoms	Results
12	W.	W.	41	5 mise., 1 S. B.	14 x 28 x 3 Dysmenorrhea, clots, menses 4 days bed	Dysmenorrhea, dysuria, pain low abdomen, consti- pated, painful uri- nation	6/6/35 Caut. cerv. supra- vag. hyst., sym- pathectomy	Cath. 1 day, con- stipated, relieved of pain	Good
13	W.	W.	24	2	14 x 28 x 5 Child 16 mos. ago, no menstruation, 1 yr. irregular	Pain in R.L.Q. 1 yr., leukorrhea, in bed 2 mos., last child, constipated	5/14/35 Caut. cerv., sus. uterus, app., sym- pathectomy	Voided regularly, constipation, dys- menorrhea relieved	Good
14	B.	W.	24	None	13 x 28 x 4 Dysmenorrhea since puberty, 4 yrs. Worse, me- trorrhagia, in bed 2 days, no clots	Dysmenorrhea, nocturia 1-2, leu- korrhea 6 yrs.	5/29/35 Sympathectomy, tubal plastic sus. uterus	Voided, all symp- toms improved	Improved
15	B.	M.	28	1	12 x 28 x 4 Dysmenorrhea	Ill 10 yrs., pain low abdomen, leukor- rhea, dysuria, noc- turia, backache, dysmenorrhea	5/15/35 Right salp.-ooph.- app. sus. uterus, sympathectomy	Cath. 3 days	Slow to void for 2 mos.; good
16	B.	M.	24	1 ab. 10 yrs. ago	Dysmenorrhea, menses irregular	Pain R.L.Q. 3 yrs., dysmenorrhea, leu- korrhea, backache, dysuria, weight in pelvis	4/9/35 Sus. uterus, sym- pathectomy, app.	Cath. 2 days, free of symptoms upon leaving hospital	Cannot locate

17	B.	M.	17	1 misc. 16 mos. ago	Menorrhagia 5 mos., dysmenor- rhea since onset menstruation, bed 2 days each month 13 x 28 x 4	Leukorrhca, dysu- ria, dysmenorrhca, pain low abdomen	4/15/35 Sus. uterus, app., sympathectomy	Cath. 1 day, re- lieved of symptoms	Good
18	B.	M.	28	1	Dysmenorrhca since onset, pain before menses, 3 days in lower ab- domen 12 x 28 x 3	Pain R.L.Q. 1 yr., leukorrhca 6 mos., dysmenorrhca	4/8/35 Sus. uterus, app., sympathectomy	Cath. 2 days, reg- ular menses, re- lieved of pain	Good
19	B.	S.	18	None	Dysmenorrhca, pain 10 days before menses 12 x 28 x 3	Dysuria 2 wks., leukorrhca 3 mos., pain R.L.Q. 2 days, blood in urine	3/20/35 Sus. uterus, app., sympathectomy	Voided, slight pain in side between periods	Imp.
20	B.	M.	32	Sterile 5 yrs.	13 x 28 x 3 Clots menses, dys- menorrhca	Low backache 1 yr., leukorrhca 1 yr., burning on uri- nation	2/17/35 Bil. salp., sympa- thectomy	Cath. 1 day, re- lieved of symptoms	Good
21	B.	M.	37	2 one abo.	12 x 26 x 3 Dysmenorrhca, clots irreg., now menorrhagia 1 yr.	Leukorrhca 2-3 yrs. Abort. 4 mos. 1926, Pain R.L.Q., dysuria, nocturia	4/20/35 Supra-vaginal hyst., fibromyoma, app., sympathec- tomy	Voided, pelvic pain improved	Imp.
22	B.	M.	31	4 one mise.	16 x 28 x 3 Dysmenorrhca	Dysmenorrhca, dysuria, pain in rt. side 2 mos., dia- betic, backache, headache, nervous	6/10/35 Supra-vaginal hyst., sympathect- omy, syphilis	Voided day of op- eration, relieved of pelvic pain and dysuria	Good

TABLE I (*Concluded*)

No.	Race	M.	Age	Para	Menstrual History	Symptoms	Operation	Postoperative Symptoms	Results
23	B.	M.	23	1 one abo.	14 x 28 x 3 Dysmenorrhea 5 mos. 1 day before flow, clots in bed 2 days	Dysmenorrhea, leukorrhea, pelvic pain	7/26/35 Right salp. ooph., sus. uterus, app., caut. cerv. sym- pactomy	Voided 7/25/35, 6 wks. postopera- tive, no menses, re- lieved of pelvic pain	Imp.
24	B.	M.	20	5 two abo.	Dysmenorrhea 1 yr. since abor., menses 1 wk. be- fore this time only 1 day. menses 11 x 3 x 28	Dysuria, dysmen- orrhea	7/24/35 Sus. uterus, sym- pactomy	Voided 7/26/35, 3 days postoperative, dysmenorrhea, later improved dys- menorrhea and dys- suria	Imp.
25	W.	M.	24	None	Essential type dys- menorrhea, irregu- lar menses, opiates required, in bed 2 days	Dyspareunia, vom- iting during men- ses, backache	D. and C. sus. of uterus, app., pre- sacral resection	Voided nor., slight uterine bleeding	Good
26	W.	M.	23	1	Severe dysmenor- rhea, in bed 2-3 days, opiates re- quired, irregular menses	Pelvic pain, back- ache, leukorrhea, nervous, lost weight	D. and C., caut. cervix, app., pre- sacral resection	Cath. 2 days	Good
27	W.	M.	24	1	Essential type dys- menorrhea since puberty, irregular	Dysmenorrhea, pelvic pain, back- ache, nervous, headache, dyspa- reunia	Appendectomy, presacral resection	Uterine bleeding, cath. once	Good

of the relief in certain cases. About 25 per cent of the colored women were luetic.

CONCLUSIONS

The results in properly selected cases of dysmenorrhea and certain types of pelvic pain were excellent in the majority of cases.

In essential dysmenorrhea, where the accepted treatment has been ineffectual, presacral sympathectomy has given relief.

Hysterectomy or a castration dose of irradiation are rarely, if ever, necessary in essential dysmenorrhea.

Intractable bladder conditions are usually relieved, and if not, greatly improved.

Presacral sympathectomy in addition to the removal of pelvic pathology, in suitable cases of pelvic pain, has increased the percentage of cures.

In the cases reported there were no complete failures, as all expressed themselves as relieved, or greatly improved. A longer period of time must elapse in the more recently operated cases to be assured of the final results. Certainly those thus far obtained are so convincing that it would seem that presacral sympathectomy deserves our most serious consideration.

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TOTAL HYSTERECTOMY

A REVIEW OF 177 CASES

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IF IT can be established that total hysterectomy from the viewpoint of mortality and morbidity is as safe as, or safer than, subtotal or supravaginal hysterectomy, it seems then that the former must be the procedure of choice in benign lesions, even though they do not require excision of the cervix for relief of the condition necessitating surgical extirpation. The thesis of this discussion is that on the average total hysterectomy can be done as safely as subtotal, and is to be preferred because the cervix left *in situ* serves no useful purpose, is often a nuisance to both patient and physician and may be undemonstrably malignant at the time hysterectomy is done or may become malignant at any time subsequent to the subtotal operation. One of us was convinced 30 years ago that the cervix should not be left when the uterus is removed, unless conditions of patient and pathology and anatomy were such that removal of the cervix would add materially to the operative risk. This report of 177 cases operated upon during the last ten years may be accepted as an effort to prove the correctness of that opinion.

There can be no doubt that a large percentage of hysterectomized women whose cervixes were not removed have no sequelae, symptomatic, pathologic or imaginary. Others, however, do have one or more of the three above indicated types of trouble.

There can be no doubt that cancer may be present and unsuspected at the time an hysterectomy is done,¹ even though careful search for its presence has been made, and that these cancers have been demonstrated postoperatively. Such a cancer of the cervix undiscovered, of course, would continue to grow in an environment favoring cure either by surgery or radiotherapy much less than if the uterus were present. General evidence justifies the conclusion that cure of cancer in the cervical stump is rarely to be expected.

When no cancer is present at the time of hysterectomy it may occur at any subsequent time.² Richardson³ gives the average incidence of cancer subsequent to subtotal hysterectomy in 10,000 cases as 1 per cent. Henriksen³ discovered that in 940 cases of cervical cancer 2.3 per cent of them were in stumps. Others believe that 4 per cent would more closely approximate the truth. A report from Lenox Hill Hospital collects 84 cancers of the cervical stump reported by seven gynecologists. C. H. Mayo⁴ reported 99 cancers of the stump between 1910 and 1930. Von Graff⁵ reports 263 cases of cancer of the cervix in Iowa State Hospitals from 1926 to 1933. Twenty-two, or 8.3 per cent, of these were in women who had had a subtotal hysterectomy. He reported from the literature 109 cases prior to 1919, and from 1920 to 1933 was able to collect from the literature, personal communication and the Iowa material already mentioned, a total of 1,169 cases of cancer orig-

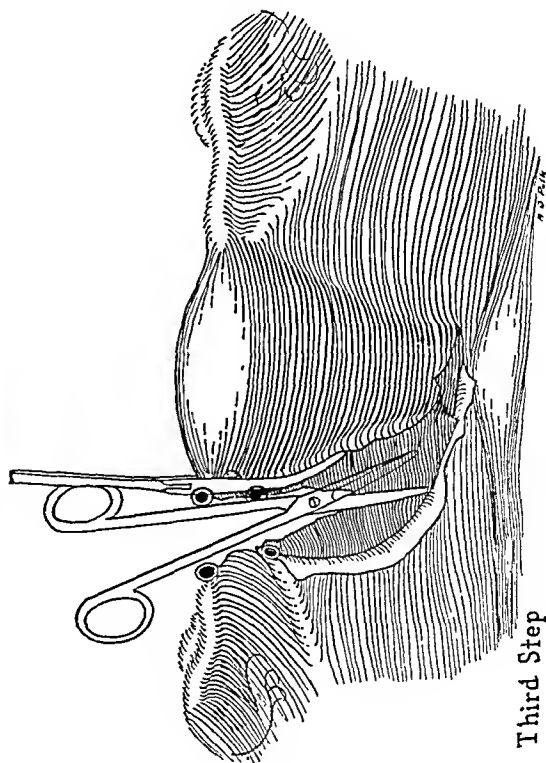
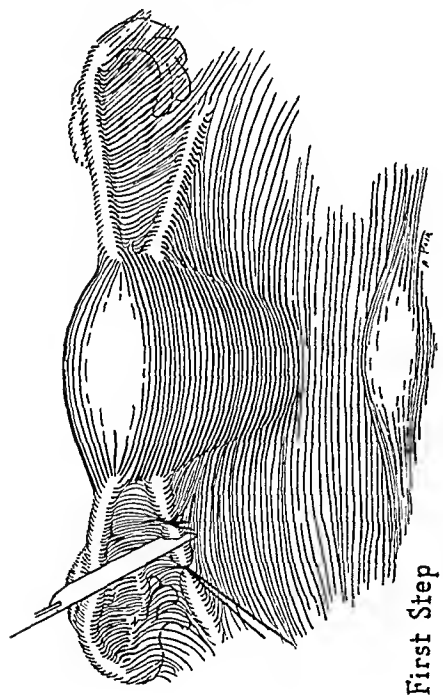
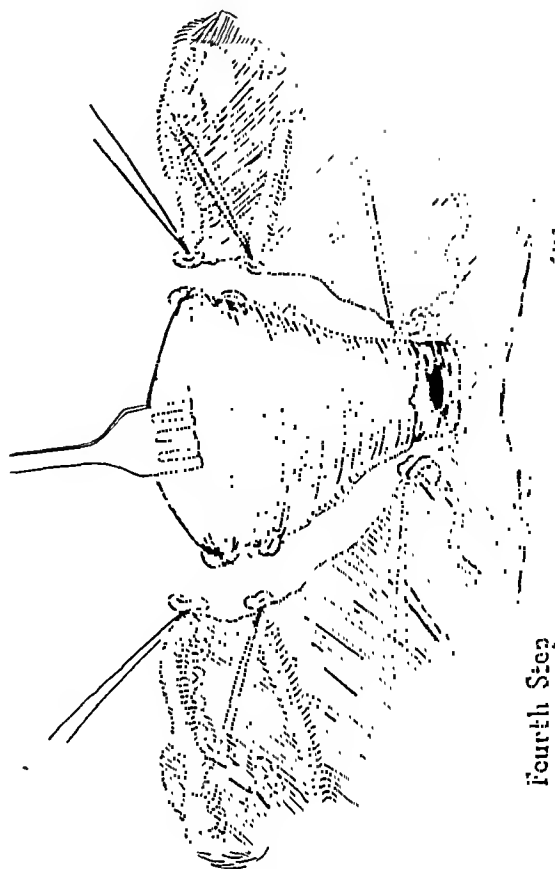
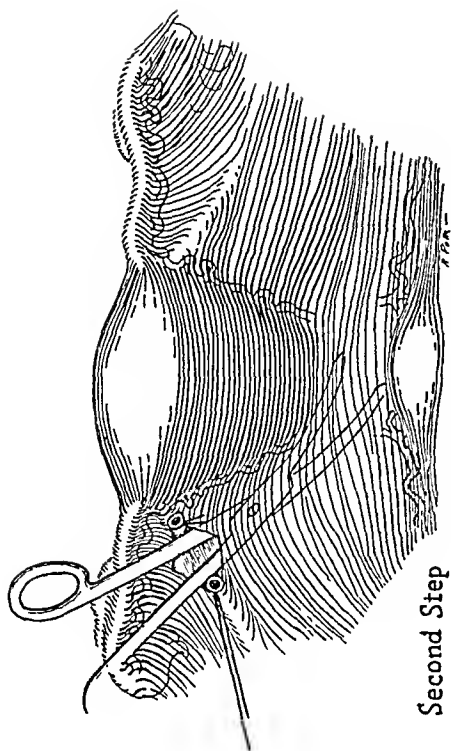
inating in cervical stumps. These records might be increased indefinitely, but only emphasize the point already demonstrated that cancer of the stump is a very real menace in the postrecovery life of those who have had subtotal hysterectomy.

Richard L. Pearse⁶ traced 1,040 of 1,900 subtotal hysterectomies; two had died of cancer of the cervix, known to be present at the time of operation; two died of unsuspected cancer of the cervix, present at the time of operation; and eight, or 1 per cent, of the 802 living at the time of the check up were known to have developed cancer of the stump. Of the 802 cases living five years postoperatively, 542 had received no treatment, but 98 of these (18 per cent) complained of vaginal discharge. Of the 260 remaining, 37 had been cauterized, 85 had had trachelorrhaphy, 121 had amputations, 10 had excision of polypi, 7 had coring out from above, and 33 (12 per cent) complained of discharge, even after these secondary operations.

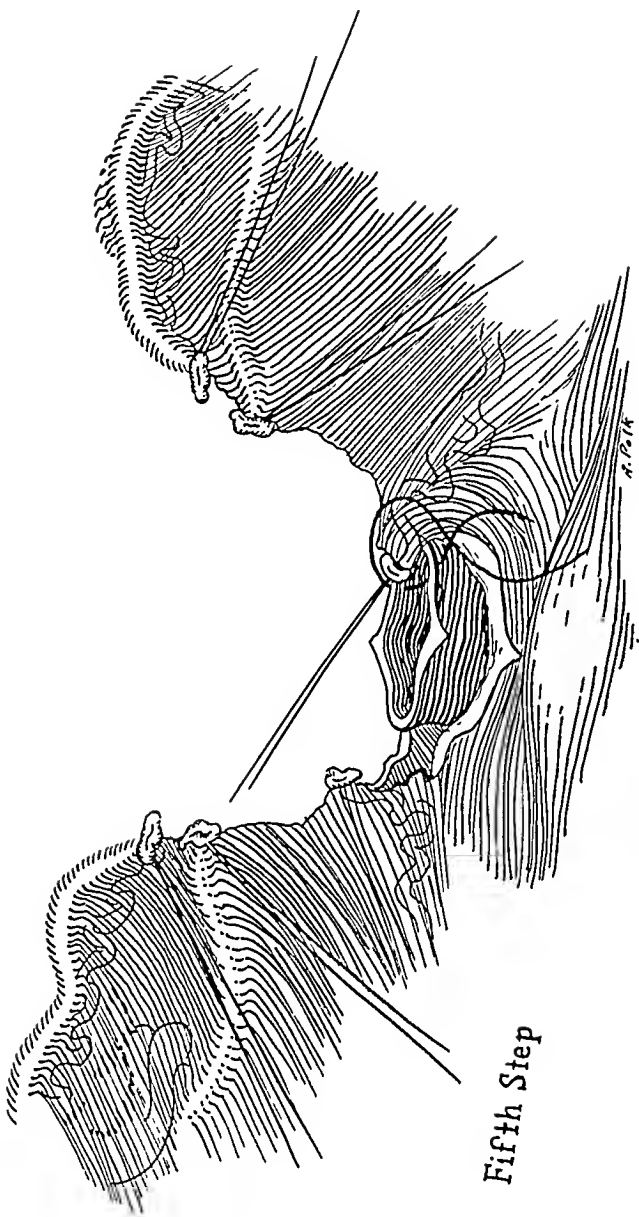
Objection has been made against removal of the cervix; that the vagina may be so shortened thereby that coitus becomes unsatisfactory. No complaint of this kind has been made in any of our cases. It is conceivable that in rare instances the ratio of depth to required depth may, by even a slight shortening of the vagina, be sufficiently altered to justify such complaint. It must, however, be rare, for in this relation nature, as usual, seems to have been lavish in her provision for exigencies and anomalies, so that even if a certain small part of vaginal depth must be sacrificed, very few, at the worst, would be any the wiser. Furthermore, if any such condition is anticipated or if it is suggested from a knowledge of the magnitude of anatomic demands that may arise postoperatively, the operation may be done with practically no sacrifice of vaginal tissue, thus causing almost no shortening, and such as is made, it would seem, may be more than compensated by removal of the cervix which occupies a definite, if variable, amount of vaginal space. By dissecting a cuff from the cervix the vagina may be actually lengthened. It is reasonable to suspect that in cases of objection to the shallowness of the vagina an unnecessary segment has been removed, or that the unsatisfactory relation is due to absence of the cervix.

The operation employed in these cases is simple, systematic and satisfactory in our hands.

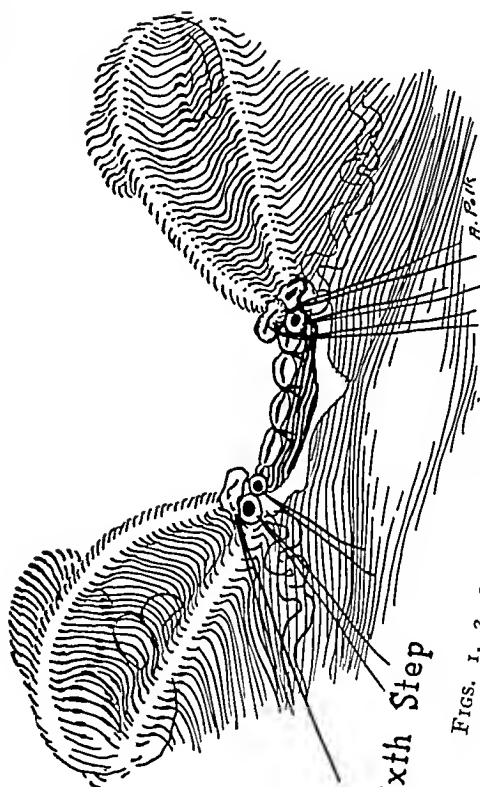
OPERATIVE TECHNIC.—General anesthesia, ether, or gas followed by ether. The vagina is prepared by first drying it and then applying 3½ per cent tincture of iodine to the cervix and the entire vaginal wall, followed by alcohol. The bladder is always catheterized after the patient is unconscious. An incision is made from the left of the navel to the symphysis pubis. The appendix is removed unless it is in such position as to entail added risk. The intestines are packed away from the pelvic viscera. The fundus of the uterus is seized with multitoothed vulsellum forceps, in such a way that the bite will not tear out during subsequent traction and manipulations. The right round ligament is doubly ligated and divided, the lateral ligature is left long for subsequent identification (Fig. 1). Scissors curved on the flat



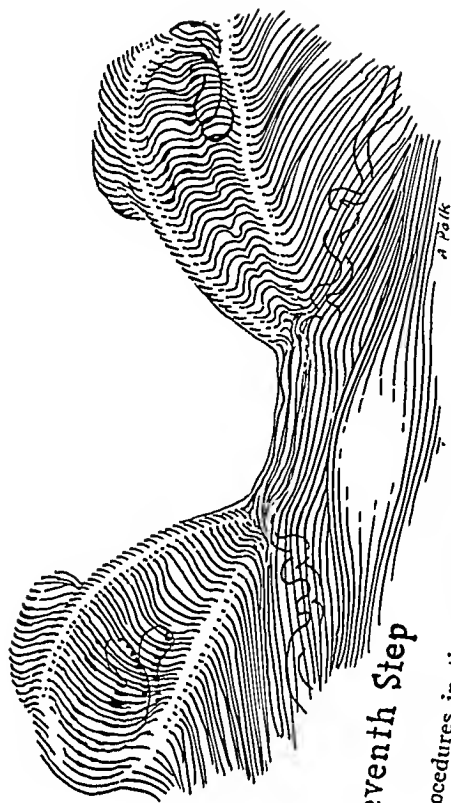
TOTAL HYSTERECTOMY



Fifth Step



Sixth Step



Seventh Step

FIGS. 1, 2, 3, 4, 5, 6 and 7.—Illustrating schematically the various successive procedures in the operative technic referred to in the text.

are inserted behind the anterior layer of peritoneum, which is separated from the broad ligament and anterior surface of the lower uterus down to the bladder by blunt dissection (Fig. 2), and is frequently carried across, almost or altogether, to the opposite round ligament. The leaf of peritoneum is severed from the round ligament in a curved direction down across the uterus and as far as possible from the bladder. The broad or infundibulopelvic ligament is now tied and a clamp placed on the broad ligament near the uterus. The ligament is then cut (Fig. 3). The ligature on the broad ligament is left long. The same steps are carried out on the round and broad ligaments of the opposite side and the separation and cutting of the anterior leaf of peritoneum is completed. The bladder is separated by being pushed down from the uterus and vagina to an adequate low level. If this dissection is done by exerting pressure downward and toward uterus and vagina and away from bladder, ligation of any vessels will rarely be necessary. The uterine vessels on each side are now ligated with No. 2 chromic catgut, at the level of the upper end of the vagina, by passing the ligature in a carrier around the vessels. These ligatures are left long. It is well if all of the six ligatures be long enough to allow the forceps holding them to drop several inches away from the abdominal incision. The uterine vessels are now divided; it is best to release all traction on vulsella while these vessels are being cut, for when the vessels are stretched the margin beyond the ligature may be deceptive and after retraction may permit the escape of the artery from the ligature. After the uterine arteries are severed, all instruments attached to the uterus, except vulsella, may be discarded. The uterus is then lifted as high as necessary through the operative wound and an incision through the peritoneum is made across the upper limit of the vaginal wall posteriorly (Fig. 4), just at the top of the breeches-like arrangement of the vagina, and forceps are applied to the vaginal edge of this peritoneum. The fascia encircling the cervix is cut down to the vaginal wall and pushed down bluntly. Fresh packs may be applied if desirable posteriorly and one should certainly be applied anterior to the uterus. The vagina is now put under tension and the lower limit of the cervix located. A transverse puncture is then made into the vagina and the distal lip of the vaginal wall caught with a clamp; if the uterus cannot be brought well up into the operative field, it helps materially to catch the upper lip with a forceps. This forceps must be strong and securely applied to the tissue in its bite. The vaginal wall is now cut around on either side and high up in the fornix and the vault until separation is complete. As the vagina is being cut it is wise to apply an occasional clamp to the wall so as to bring it more readily up into view for closure. If there is an accumulation of blood or mucus in the upper vagina a dry sponge may be pushed down into it and left for removal until the end of the operation. As soon as the uterus is removed the cut edge of the vagina is touched with 3½ per cent tincture iodine. The vaginal opening is sutured with No. 2 chromic catgut. The first sutures are applied laterally and are made to embrace not only vaginal wall, but the already tied

uterine vessels (Fig. 5). Then the infundibulopelvic or broad ligament is brought down and tied against the vagina with the same suture and on top of this the round ligament is tied, securely fixing these normal supports to the vagina and effectively preventing its descent. The intervening space is closed with interrupted sutures (Fig. 6). A pursestring is passed from the projecting peritoneum of the bladder through round ligament, tube, posterior surface of broad ligament and the peritoneal covering of the posterior vaginal wall and tied covering all stumps of ligated structures on one side. It is continued by gathering the bladder peritoneum and leading it across the top of the vagina and suturing it to the posterior vaginal wall. On reaching the opposite side a final pursestring covers all raw surfaces (Fig. 7).

When the total operation cannot be done for any cause either a supra-vaginal or the somewhat more desirable operation of coring out the cervix is performed.

It is difficult to arrive at a fair conclusion of the relative mortality of total and subtotal hysterectomy. Any surgeon would prefer to do a subtotal when for various reasons the total offered greater risk to life. This practice tends to reduce the mortality of a total and to increase that of a subtotal hysterectomy. If a large number of operators' results can be averaged, the chance of error is reduced, although the excuse for argument in favor of either side cannot be eliminated. We have averaged reports of a large series of cases by various authors (Table I). Some of these do a majority of total hysterectomies, others a majority of subtotal operations, a few about an equal number of each. The lowest mortality in the subtotal group was 1.1 per cent of 258 cases (Phillips⁷), 1.2 per cent in 3,085 cases (C. H. Mayo⁴), 1.6 per cent in 1,253 cases (Amreich⁸). The lowest mortality in total group was 0 per cent in 76 cases (Macafee²), 0.5 per cent in 200 cases (Treston⁹), 1.12 per cent in 89 cases (Griffith¹⁰), 1.3 per cent in 229 cases (Masson¹¹), and 1.8 per cent in 1,588 cases (C. H. Mayo⁴). Aggregating the cases, there are 21,945 subtotals with a mortality of 2.73 per cent, and 8,442 cases of totals with a mortality of 3.28 per cent, a difference in favor of subtotal hysterectomy of .5 per cent or 1 in 200. If cognizance is taken of the fact that the total hysterectomy cases in these collections embraced large numbers of cancer patients, which should give a higher mortality, it would seem fair to estimate this increase of .5 per cent as explainable on the ground of pathology rather than on that of operative hazard. The explanation that the mortality of subtotal group is increased similarly, because they embrace those cases in which total hysterectomy was considered more dangerous, cannot be satisfactory because the authors reporting the largest number of cases did from 3 to 12 times as many subtotals as totals, and no such proportion of cases can be suspected as being unsuited for total hysterectomy. A more satisfactory explanation would be that they did the subtotals by preference, and the totals from necessity. Even then the mortality is almost identical.

TABLE I

PERCENTAGE MORTALITIES OF 21,945 CASES OF SUBTOTAL HYSTERECTOMY
AND 8,450 CASES OF TOTAL HYSTERECTOMY

Ref. No.	Surgeon	Subtotal		Total	
		No. of Cases	Mortality, Per Cent	No. of Cases	Mortality, Per Cent
12	Rinaman and Sellers.....	179	2.8	62	9.6
13	Kostmayer.....	980	6.22	454	9.03
14	Bartlett and Simmons.....	2,733	1.7	329	7.9
15	Siddall and Mack.....	1,141	2.6	235	6.4
16	Shaw.....	232	3.05	67	5.9
17-18	Graves.....	1,399	1.57	119	5.0
19	Greenhill.....	1,857	4.47	551	4.72
7	Phillips.....	258	1.1	199	2.5
8	Amreich.....	1,253	1.6	409	3.8
1	Read and Bell.....	1,739	2.1	605	3.1
20	Mayo, C. H.....	3,085	1.2	1,588	1.8
21	Bauer.....	50	2.0	50	2.0
22	Fullerton and Faulkner.....	609	4.4	1,078	4.1
10	Griffith.....	604	2.3	89	1.12
23	Burch and Burch.....	166	4.2	32	3.1
9	Treston.....	100	4.0	200	0.5
2	Macafee.....	46	4.35	76	0.0
11	Masson.....	217	1.8	229	1.3
	Ford Hospital.....	122	3.2	476	2.9
7	Lockyer.....	284	1.7	195	1.5
24	Miller.....	2,991	4.9		
6	Pearse.....	1,900	1.7		
25	Von Graff.....			200 plus	0
26	Worrall.....			532	0.56
27	Davidson.....			165	1.8
28	Spencer.....			325	1.8
	Bryan, W. A.....			177	2.8
Totals.....		21,945	2.73%	8,442	3.28%

Of the 192 hysterectomies performed during the past ten years, 177 were total and 15 subtotal, almost 12 to 1. No other major operation was performed at the same time, even though felt to be definitely indicated. Two major operations done separately are safer than if both are done at the same sitting. Appendectomy was, if possible, routinely done, hemorrhoidectomy in an occasional instance, and when necessary, perineorrhaphy. If at all possible some ovarian tissue, if not all, was left in women who had not reached the climacteric. The rule has been to remove the adnexa in women past the menopause, unless such removal would tend to increase the risk unjustifiably.

There were five deaths in the series, a mortality of 2.6 per cent, or 2.8 per cent of the total hysterectomies. One died of secondary hemorrhage fol-

lowed by pneumonia; one of acute dilatation of the stomach on the seventh postoperative day; one of acute cardiac failure (embolism?); one of secondary hemorrhage. This woman had been treated with radium a year previously for hemorrhage. The hemorrhage recurred and the uterus was removed. Ten days after operation she began to bleed slowly from a small vessel in the raw surface of the vaginal vault, and in spite of our ability to see the bleeding point nothing we did would control it. One died three weeks postoperative with no cause assigned in the record and none probably assignable. She could eat, but refused. When asked her trouble she said she wanted to die. If I should assign a cause, it would be domestic infelicity. There were no deaths in the small subtotal group. There were only two cases of extended morbidity. These were both fat women and both had a mural abscess.

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DISCUSSION OF THE PAPERS OF DOCTORS BARR AND BRYAN

DR. THOMAS S. CULLEN (Baltimore, Md.).—From 1900 to 1909, I spent most of my spare time in analyzing the histories of 1,674 myoma cases that had been operated upon by Dr. Howard A. Kelly, myself, and by our associates. Every phase of the subject was considered in the "Myoma of the Uterus," published in 1909.

After weighing the matter carefully, we came to the conclusion that, as

a rule, supravaginal hysterectomy was the operation of choice in cases of myomata of the uterus. It is perfectly true that occasionally a carcinoma will develop in a cervix that has been left behind. It is perfectly true that in about 1.7 per cent of our cases, carcinoma of the body of the uterus was noted, complicating the myomata, and that in over 1 per cent sarcoma developed in or was associated with the myomata.

Notwithstanding these percentages of malignancy, the simplicity of the supravaginal operation with its lessened risk of injury to the ureters, and with its lessened risk of infection, due to the vagina not being opened, seemed to us in the end to give better final results than did complete hysterectomy. In all cases where the cervix looked suspicious at operation, naturally, a total hysterectomy was performed.

As a routine, where the supravaginal hysterectomy was performed, the uterus was opened the minute it was removed, and if, by chance, a carcinoma of the body existed, then the cervix was removed at once, likewise, the myomata are cut open as soon as the uterus is removed, and if there be the slightest sign of sarcoma the cervix is at once taken out.

In all cases where the menstrual function still persists and where the ovaries can possibly be saved, they are left *in situ*.

Many surgeons have advocated complete removal of the uterus in cases of myoma, and as the years go by we are more and more convinced that the supravaginal operation is the better procedure in these cases.

DR. CHARLES R. ROBINS (Richmond, Va.).—I agreed with the essayists for a number of years but have had to change my point of view; and from regarding hysterectomy as an operation of selection I now regard it as one of necessity only. One thing has given me more trouble than anything else, and that is the change in the vagina. When one performs a total hysterectomy, especially when the ovaries are removed, the vagina undergoes a senile change, and instead of having a moist organ it becomes a dry organ, which causes a lot of trouble. They speak of shortening the vagina, but it is not because the vagina is short but because it is dry. If there is any satisfactory treatment for a dry vagina I would like to know what it is.

I have found by abundant experience that we can in a number of these cases avoid doing total hysterectomy. In cases with fibroids we know that they do not have much tendency to invade the lower part of the uterus. They are seldom in the cervix. We now take out the fundus, leave the tubes and ovaries, and have a miniature uterus which is very satisfactory. As far as the cervix is concerned, while it is true that removal is a good prophylactic measure, there are a good many other things that can be done. As far as doing a total hysterectomy for inflammation is concerned, the results we are obtaining from the Elliott treatment are so excellent that I think a hysterectomy will be much less frequently resorted to than it is at present.

In referring to mortality, I think a great many patients would rather die than live with a dry vagina.

DR. EMIL NOVAK (Baltimore, Md.).—In both these papers a number of controversial subjects are discussed, but only one or two points can be touched upon. Concerning the operative technic of hysterectomy I shall say nothing, especially as every surgeon has his own little bag of refinements and tricks. I was surprised to hear Doctor Barr's statement as to the removal of the tubes and ovaries; I see no necessity for removing normal adnexa in non-malignant cases unless there is some definite indication. Gynecologists are pretty well agreed that the retention of normal ovaries lessens the frequency and severity of menopausal symptoms. If the tubes are healthy, it is better

to save them also, for they cause no trouble, while their removal, when the ovaries are conserved, means a disturbance of the nutrient blood vessels of the ovary, which course between it and the tube.

The much discussed question of whether the hysterectomy is to be total or subtotal must be decided on the basis of the individual case. Those who always, or never, do one or the other are equally open to censure. For example, if a patient needing hysterectomy has an ugly, eroded cervix, I would go to a good deal of trouble to do the total operation, even if it were technically difficult. But if the cervix was quite normal, in a very stout woman with a very deep pelvis, where the total operation would be a difficult and perhaps hazardous one, I would certainly choose the subtotal procedure. I do not see how, on mere *a priori* grounds, the routine adoption of total hysterectomy could fail to carry with it a higher mortality than the subtotal method, in spite of statistics to the contrary in some reported series.

DR. F. WEBB GRIFFITH (Asheville, N. C.).—Referring to Doctor Bryan's paper, he stated that a total is almost as safe as a subtotal hysterectomy. Frankly, I doubt this. My personal statistics show 14 deaths; a mortality much higher in total than in subtotal procedures, and the majority of the cases were subtotal. I think if we adopt the idea that we will do practically all cases by total hysterectomy, we will have trouble and a higher mortality. If you fear malignancy, I think it is better to do a subtotal operation, and if necessary, remove the cervix from below, accomplishing the same result. In a group of 634 cases there was one malignancy occurring in the stump. I firmly believe that if total hysterectomy is persisted in with the idea of preventing carcinoma, you will have a higher mortality than if it is left alone.

DR. RICHARD A. BARR (closing).—Doctor Novak has said that removal of the tubes interferes with the blood supply of the ovary. That reminds me of what Dr. John G. Clark once said, quoting an Englishman's statement with regard to an opinion expressed by a French surgeon: "He is a great man and I have to believe him, but God knows it was not so." Who ever heard of a blood vessel running from the tube to an ovary? The arteries run very definitely from the ovary to the tube. Of course, if you tie the ovarian ligament you interfere with the ovary directly, but not by just removing the tube. I leave the matter of removing the ovary to the judgment of the surgeon and the wish of the patient. However, some of the most difficult surgery I have had to do was necessitated by ovaries or pieces of ovary that had been left. One in which a piece of ovary had been stuck in the broad ligament developed a very extensive and peculiar new growth. My observation has been that the patient of the age I usually operate upon does not miss the ovaries.

As for Doctor Robins' statement that hysterectomy is an operation of necessity, that is correct and necessity is the only reason for doing it. It is a necessity if I am going to please the patient and the family doctor. So far as lubrication of the vagina is concerned, I have the impression that lubrication at the inlet is far more important than at the top.

DR. WORCESTER A. BRYAN (closing).—Very early in my work I got cured, perhaps by a scare, by seeing two young women in whom both ovaries had been removed during an hysterectomy in the same hospital at the same time. They made so much disturbance—they may have been plain crazy, I do not know, but I thought it was because their ovaries had been removed—that I was cured right then about taking ovaries out. I appreciate what has been said about taking out the cervix, but I will continue to take it out until I find that I am wrong about it.

NEPHROPEXY FOR DISABILITIES DUE TO ABNORMAL RENAL MOBILITY

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IN PRESENTING for consideration the subject of altered renal mobility, we are fully aware that it is one which, during the past few years, has received a great deal of very partisan discussion.

The Viennese, Meuse, in 1568, gave what is probably the first description of a movable kidney. Riolan, in 1682, was the first to describe nephroptosis as a symptom producing lesion. During the next two centuries medical literature contained occasional references to nephroptosis and its symptomatology. In 1874, an American, Dr. Greenville Dowell, was the first to attempt a nephropexy, and although Dr. Dowell did not recognize the true nature of the movable tumor mass in the right flank he believed that its fixation would lessen the severity of the patient's symptoms. His method was, in the light of present knowledge, rather courageous and is worthy of note. He passed a large curved needle to which was attached a tape through the anterior abdominal wall, the tumor mass, and out the flank. The two ends of the tape were then brought together and tied. Except for a short period of hematuria the patient's postoperative convalescence was uneventful. The symptoms were relieved for about four months, when the tape broke and the mobility recurred. Later attempts at fixation by the same method were unsuccessful and a nephrectomy was necessary.

The first premeditated attempt at nephropexy was by Hahn, a German, in 1881. The first successful operation of this type in America was by Weir in 1883. During the next two and one-half decades the treatment of nephroptosis by nephropexy was given the universal support of the medical profession. This enthusiasm became so marked that it even caused the establishment of a chair of nephroptosis in one of our medical schools. This attitude created a situation that was indeed unfortunate, for the diagnosis of nephroptosis and the surgical technic of nephropexy became purely routine procedures that were frequently attempted by those unprepared to make the diagnosis or to perform a nephropexy. Although many patients were completely and permanently relieved of all symptoms, the frequency of unsatisfactory postoperative results, because of inaccurate diagnosis, and the misapplication of the principles of nephropexy, caused the procedure to fall into such universal disrepute that from 1915 to 1925 the profession, as a whole, paid little or no heed to the condition of nephroptosis.

During the past few years the increasing accuracy of urologic diagnostic methods has prompted a more scientific study of renal mechanics and has



Fig. 1.—Kidney in normal position with anterior layer of perinephric fascia removed.

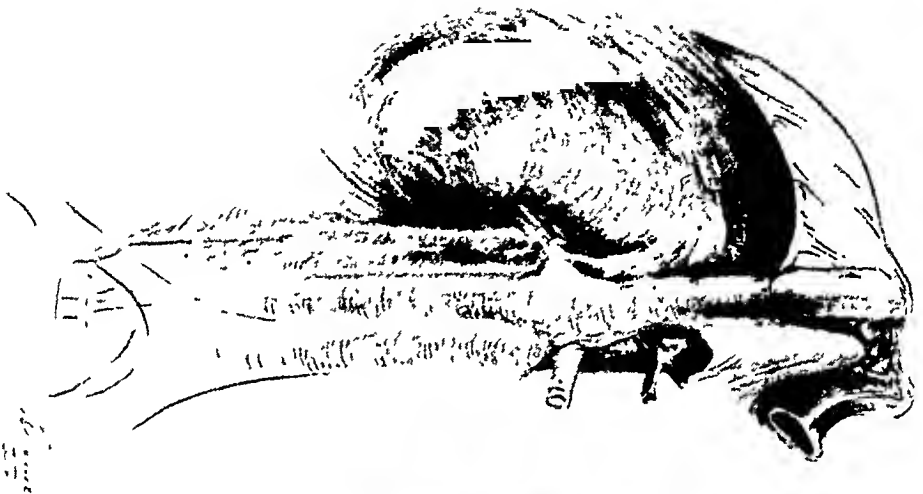


Fig. 2.—Kidney in normal position showing the anterior layer of perinephric fascia.



Fig. 3.—The normal relationship of the duodenum to the kidney and perinephric fascia.

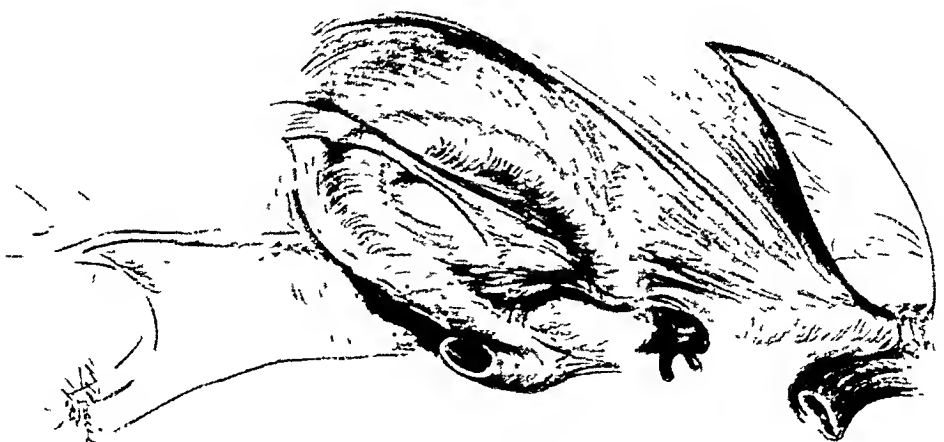


Fig. 4.—The kidney in low position. The extent of the alteration in the position of the duodenum by the drag of the perinephric fascia is illustrated.

revealed that abnormality in renal mobility is an extremely common condition. We wish to present an evaluation of the importance of the rôle played by certain mechanical factors resulting from altered renal mobility in the production of the symptoms of nephroptosis.

The following report is based upon a study of 238 nephropexies performed on 204 individuals in the 14 years prior to January 1, 1934.



FIG. 5.—The kidney in low position with the anterior layer of perinephric fascia removed. The pull and torsion of the renal pedicle is shown.

The statistics as to age, sex, and the side affected coincide with other previously recorded studies. In 30 cases other operative procedures, such as pyelolithotomy, and resection of small solitary cysts, were combined with the nephropexy. In 22 cases nephropexy was combined with nephrolithotomy, heminephrectomy, and plastic operations on the renal pelvis.

As we wish to discuss the alterations in the normal anatomic relationships produced by abnormal renal mobility, and the manner in which they may cause symptoms, it is well to describe briefly the normal relations of the kidney and to state rather arbitrarily that normal renal mobility is never in excess of $2\frac{1}{2}$ cm. Although movement in excess of this figure is not infrequently found, it can no more be regarded as anatomically normal than can the relaxed abdominal wall of the multipara.

The kidney is a mass of glandular tissue with a drainage system comprised of the renal pelvis and ureter. Its vascular supply, the renal artery and vein, constitute the pedicle. This mass of renal tissue is surrounded by a thin, but rather dense, non-elastic, fibrous capsule and is embedded in

and cushioned by fat in its own fascial compartment. Within this compartment the ureter courses to a point about 1 cm. below the normal level of the lower pole of the kidney where it becomes attached to the anterior layer of perinephric fascia (Fig. 1). This fascial compartment is formed by the division of the deep fascia at the midaxillary line into two layers. One layer passes posterior to the kidney to fuse with the fascia of the bodies of the lumbar vertebrae, the other anterior to come into contact with the fascia of the midbody line and to fuse with that from the opposite side. Above, these two layers fuse, and below, they come into very intimate contact (Fig. 2). Immediately in front of this anterior layer of fascia, on the right side, is the duodenum, which in this location is completely retroperitoneal

and is rather intimately attached to this fascial layer. The hepatic and splenic flexures of the colon are also in intimate relationship with the kidneys (Fig. 3).

Before considering the changes in these normal anatomic relationships occasioned by altered or excessive renal mobility, it is well that we definitely understand the real cause of renal colic. We believe that it is logical to regard the basic cause of renal colic to be an increased intracapsular tension within the kidney, and that the severity of the pain thus produced is directly dependent upon the rapidity of the development, and the degree, of this increased tension. In this connection we must remember the very important fact that, although there is only one entrance for fluid into the kidney, the renal artery, there are two separate and distinct exits, the ureter and the renal vein, and that interference with the efficiency of either of these two exits will produce the increased intracapsular tension necessary to cause renal colic. By far the most severe attack of renal colic in our experience resulted from the pressure of a small aneurysm of the abdominal aorta on the right renal vein.

When renal mobility is increased for any reason whatsoever, traumatic or otherwise, nature attempts to arrest this excessive movement by the absorption of the intracapsular fat and its replacement by adhesions between the renal capsule and perinephric fascia. As renal mobility continues to increase, the kidney will follow the plane of the posterior body wall, and the lower pole will be rotated outward and medially. The weight of the low rotated kidney is to a great extent transferred through its partially twisted pedicle to the splanchnic area and its low position predisposes to a kinking of the ureter (Fig. 4). The anterior layer of the perinephric fascia will be pulled downward resulting in a definite displacement of the midportion of the duodenum (Fig. 5).

Thus there are four factors that may be of importance in the production of symptoms. These are discussed in what we believe to be the order of their relative importance.

(1) The tension upon and torsion of the renal pedicle usually causes a sensation of heaviness and weight in the side affected and frequently interferes with the return flow of blood through the renal vein, to such an extent as to produce attacks of renal colic in patients in whom there may be no evidence of renal stasis.

(2) The excessive sympathetic stimulation, as a result of the constant pull upon the splanchnic area, may manifest itself in many ways, and probably plays a rather important rôle in the production of the dyspeptic symptoms so frequently found in these cases. The frequency of intense headaches and of pain that is referred to a point midway between the scapulae may also result from this excessive stimulation. The so called neurasthenia so commonly found in neglected cases of nephroptosis is undoubtedly due to excessive sympathetic stimulation.

(3) The sagging of the midportion of the duodenum can be demonstrated



FIG. 6.—Illustrative case of Group I showing very little increase in vertical movement but rotation about the pedicle due partially, in this case, to an associated congenital anomaly.



FIG. 7.—Illustrative case from Group II demonstrating anterior rotation of the lower pole.



FIG. 8.—Illustrative case of Group III.



FIG. 9.—Typical case of Group IV with definite evidence of renal stasis.

easily by fluoroscopic examination of the gastro-intestinal tract, particularly if this be done in the standing position and in conjunction with retrograde pyelography. Although this is undoubtedly a contributing factor in the production of gastro-intestinal symptoms, we are not certain of its real importance. The close proximity of the splenic flexure of the colon to the left kidney may explain the frequency with which we see that symptom complex called "colitis" associated with a low left kidney.

(4) The frequency with which ureteral kinks are demonstrated in cases of nephroptosis is probably quite misleading. It is not felt that they are of

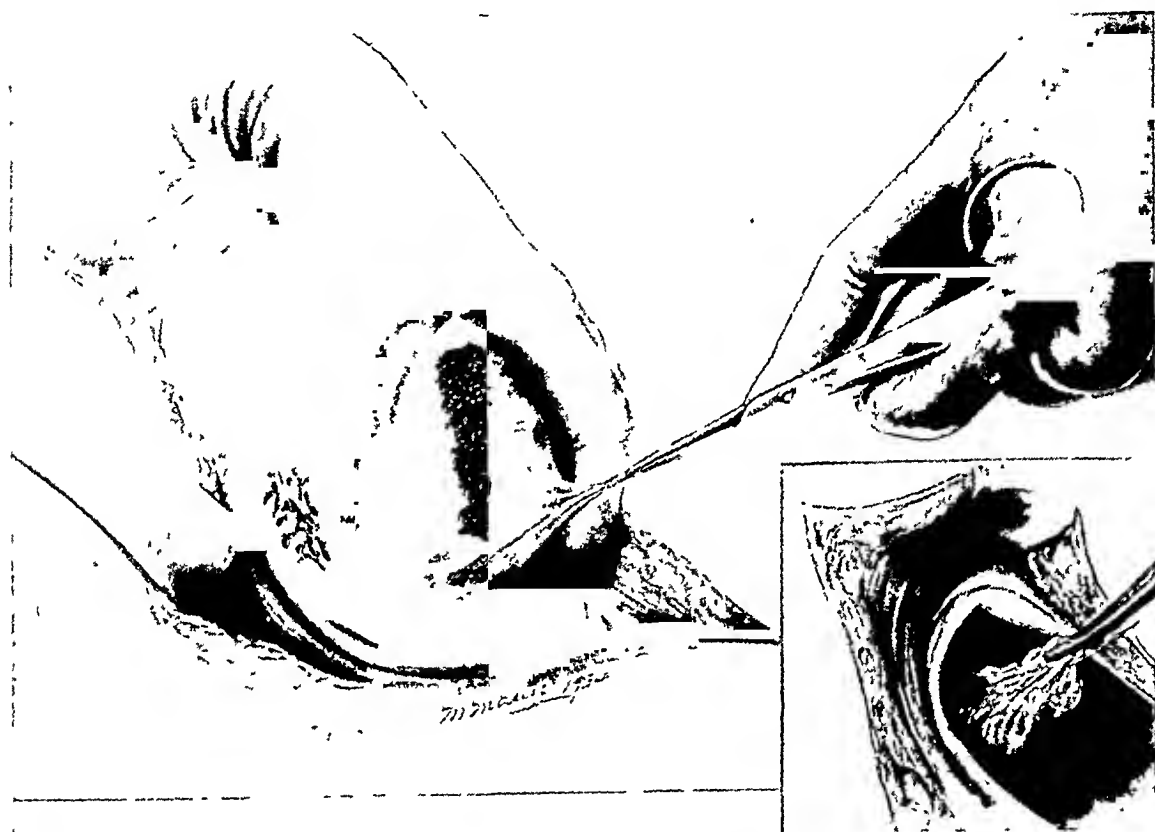


FIG. 10.—Adherent fibrous and adipose tissue is removed from the renal capsule and renal fossa. any particular clinical importance unless there is evidence of renal stasis or of chronic infection of the renal pelvis.

Two types of altered renal mobility are recognized; the asymptomatic, and the symptomatic, which comprise at least 60 per cent of the total cases. We have chosen as a basis of discussion a classification of this latter group based entirely upon symptomatology, although the extent of alteration in mobility in each of these groups is rather constant.

Group I is characterized by attacks of very acute excruciating pain, simulating renal colic; the other symptoms of nephroptosis are seldom present. This type is found almost as frequently on the left as on the right side. Very often the patient can date the onset of his symptoms from the time of some unusual physical exertion or an accident. Examination may show very little increase in vertical movement, but occasionally shows some evidence of rotation about the renal pedicle (Fig. 6). Diagnosis may be extremely difficult and is dependent almost entirely upon the elimination of all

other causes of renal pain. With patients of this type, a rather tight adhesive band three to four inches wide extending about two-thirds around the body on the affected side is applied immediately below the kidney, with the patient in a recumbent position. This band is kept in place for several weeks. Even in the cases with moderately severe pain it is frequently successful, but in those with violent attacks of pain operation is usually necessary. Four and one-half per cent of our operative cases are of this type. They have all had a very satisfactory result.



FIG. 11.—The nephropexy stitch.

Group II is characterized by marked gastro-intestinal symptoms suggesting pyloric or duodenal obstruction. Occasionally these are so severe that they have been the cause of previous operations, such as appendectomy, cholecystectomy, *etc.* A sensation of heaviness and weight in the side is always complained of, particularly in the afternoon or evening or after unusual physical effort. The patients have rather frequent attacks of acute renal discomfort, but not necessarily colic. Examination shows a kidney with an increase in vertical movement of about one and one-half inches, and some evidence of outward rotation of the lower pole. There is seldom any evidence of urinary stasis (Fig. 7). In this group all types of palliative procedures have in our experience proven uniformly unsuccessful. While

there have been many disappointments in this class of case, there have also been some most gratifying results. An example of the latter was a neurasthenic student, aged 22, weighing 112 pounds, who gave a history of five years' duration during which time he had had in sequence a gastro-enterostomy, a cholecystectomy, an appendectomy and 17 ureteral dilatations, each of the latter having been followed by some relief for a week or so. Six months after nephropexy he resumed his studies, weighed 152 pounds, and was active in athletics.

Approximately 20 per cent of our operative cases are in this group. Of the 48 individuals in this group, 17, or 37.6 per cent, had a persistence or



FIG. 12.—The ends of the nephropexy stitch are brought through the intercostal space as a mattress suture.

recurrence of some of their symptomatology for more than six months. There are only nine who were not completely well after one year; four of these, one a bilateral case, were improved but still have moderately severe dyspeptic symptoms and some discomfort in the region of the kidney. In five, the symptoms remained so severe that nephrectomy was performed.

Group III is characterized by occasional attacks of rather severe renal colic and a marked tendency toward a recurrent pyelitis and hematuria. Chronic dyspeptic symptoms are usually present. There is in these cases a definite tendency toward neurasthenia. Examination shows the kidney to have a movement of from two and one-half to three inches, and frequently gives evidence of urinary stasis (Fig. 8). It is in this group, which comprises 48 per cent of our series, that we have had the most uniformly satisfactory results. In only five instances has there been, after one year, a

persistence of any of the symptoms. With the exception of one case with intermittent hematuria, these were of a rather minor character. Although there were 11 cases in this series in which, at the time of nephropexy, a pyelolithotomy was also done, we have no record of a recurrence of renal calculi. Renal infection, which was present in 18 cases, was completely cleared up within eight months in all except two cases. The one surgical death in our series occurred in a case of this type and was due to a staphylococcal septicemia. We do not advise the use of palliative procedures if surgical repair is possible, as they are seldom of any permanent value.

Group IV is characterized by more or less constant heaviness and drag-

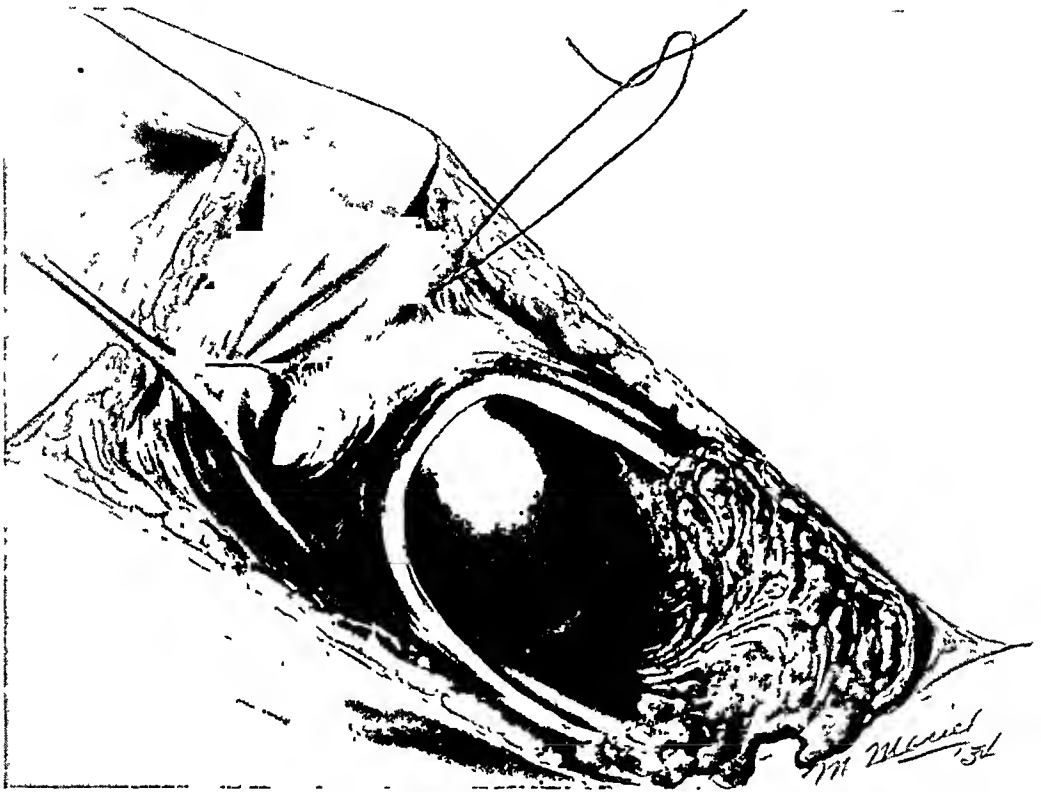


FIG. 13.—Nephropexy stitches in place.

ging in the side, and usually has symptoms suggestive of chronic renal infection. If these symptoms are on the right side, chronic dyspeptic symptoms of a mild type are usually present. Examination shows a very low kidney and usually a dilated and infected renal pelvis. Calculi are frequently found (Fig. 9). Twenty-eight per cent of our operative cases were of this type. The postoperative results in this group have been very satisfactory, although the chronicity of the urinary infection and the hydronephrosis that is usually present have in some cases required a rather long period of postoperative therapy. In 13 instances renal calculi were removed at the time of the nephropexy, and there were two cases of associated solitary cysts in which resection was done. In one case the calculi have recurred.

Palliative therapy may in this group afford a definite measure of relief,

but we must bear in mind that all palliative procedures are to be regarded as affording only temporary relief. When it is decided not to operate, we advise the use of an adequate abdominal support. Renal infection which is usually present is treated by pelvic lavage, dietary measures, *etc.*

DIAGNOSIS.—It is unnecessary to discuss the details of diagnosis, other than to state that a proper study of these cases requires that pyelograms be made in the upright position. We prefer to avail ourselves of the advantages to be derived from ureteral catheterization and retrograde pyelography.



FIG. 14.—The anterior layer of the perinephric fascia is anchored in place.

THERAPY.—The type of therapy operative or otherwise to be advised in any particular case requires the utmost cooperation of the patient's physician, the gastro-enterologist, the radiologist, and the urologist. The decision in favor of surgical intervention should be made only when it is determined that the subjective symptoms are a definite handicap to the patient's physical welfare and only when the operation is not contraindicated by genito-urinary pathology which cannot be relieved by nephropexy or by coexistent pathology in other organs. Our experience coincides with that of most urologists, in

that the presence of obstructive ureteral lesions due to true strictures is infrequently encountered.

SURGICAL TECHNIC.—We believe the technic of the surgical restoration of normal anatomic relationships of the kidney should under no circumstances be destructive and should require no more tissue destruction than is consistent with a guarantee of the permanency of the restoration.

The kidney is exposed through a lumbar incision, the posterior layer of the perirenal fascia is incised, and the anterior layer carefully preserved. The kidney is freed of its perinephritic adhesions. An exploration is made to determine if anomalous vessels are present and interfering with the restoration of the kidney to its normal position. If present, they are divided. The ureter, if kinked, is freed, the renal capsule is preserved intact and carefully cleansed of all adherent fibrous and adipose tissue, as is also the posterior portion of the renal fossa (Fig. 10). The most ideal position for this particular kidney is accurately determined, special care being taken not to select a point either too high or too low. The kidney is fixed in position by means of two No. 3 chromic catgut sutures, which we rather inadequately describe as a cross stitch in the renal capsule (Fig. 11), the ends of which are brought through the intercostal space as a mattress suture (Figs. 12 and 13). After anchoring the kidney, the anterior layer of the perinephric fascia is brought into its proper position, thus supporting the posterior layer of the peritoneum (Fig. 14).

Postoperative Results.—The vast majority of unsatisfactory postoperative results are due to one or more of the following causes: (1) Failure to restore the kidney to its proper position. (2) The production of excessive trauma about the renal pedicle or ureter at the time of operation. (3) Failure to recognize coexistent pathology of the kidney or adjacent organs.

While in certain groups the percentage of our unsatisfactory postoperative results may seem to be somewhat high, we believe that it should not be regarded as a criticism of the surgical technic of nephropexy, but of the manner in which that technic was applied to the particular case, and that by proper study these unsatisfactory results can be gradually eliminated. We feel that a study of the more recent cases of our series will confirm this suggestion.

CAUTIONS IN THE TREATMENT OF URETERAL CALCULI

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IN REVIEWING the literature on ureteral calculi one is impressed with the variance of opinion founded on the experience of individual operators. As brief examples among some of the leaders of urologic thought, Bumpus and Thompson found that 60 per cent of stones in the lower ureter could be removed by manipulation. Caulk states that 90 to 95 per cent of all ureteral stones will pass without operation. Winsbury-White reports 55 cases in which 13 were operated upon. Although it is a small number, we have tabulated our last 100 cases in which positive stones were demonstrated, chiefly to see how much less fortunate we were than others and in that tabulation were interested to see if we could make any instructive criticism. The following data were obtained:

Males.....	83
Females.....	17
Right side.....	44
Left side.....	66
Upper third.....	12
Middle third.....	22
Lower third.....	66
Open operation.....	9
Upper third.....	1
Middle third.....	4
Lower third.....	4
Mortality.....	2
Cystoscopic manipulations (2 or more cystoscopies)...	59

Those stones which are passed after a little manipulation escape our consciousness rather readily, but it is upon those which persist that our attention is focused and we begin to look for causes why these do not pass more readily.

Because manipulation by ureteral instruments has been so successful we naturally look to that method first. The chief symptom of almost every patient with ureteral stone is colic. That this pain is caused by blockage and distention of the renal pelvis is almost universally accepted. This alone should make one realize that therein lies the danger from ureteral stone, *i.e.*, subsequent damage to the kidney. It becomes immediately imperative to remove this obstruction not only on account of the pain but because of the potential damage that may be done. Often after one or two attacks of ureteral colic the patient never has another and if the obstruction is not removed the kidney often goes on to complete disintegration, either from hydro-nephrosis or atrophy, without a subsequent symptom. For these reasons it

is a fundamental law that no stone in the ureter should ever be disregarded until it is evacuated.

Because stones vary so greatly in shape and size the procedures for their removal are likewise diverse. Size in itself is often sufficient to convince us that only operative methods should be employed even though calculi of surprisingly large diameters have been extruded through the orifice. If a large stone passes down to the ureterovesical orifice, then removal by incising the orifice through a cystoscope is often a practical method. Likewise, if the ureter is greatly dilated the possibility of passage of a large stone is much enhanced.

Small stones are often the cause of more trouble than large ones. Especially is the rough and spiculated one likely to lodge in the ureter and adhere tenaciously. In some cases where repeated manipulations have failed to effect dislodgment we have found upon ureterolithotomy that the stone was so imbedded in the ureteral wall that the use of a pointed instrument was required to dislodge it. This is the type of stone that makes manipulation so hazardous. We must be constantly on the alert for fear of injuring the ureter in these cases. We believe that damage does occur more often than is recognized. By the routine use of postmanipulation ureterograms we have found four definite instances of extravasation of the media. It is this finding especially which has caused us to consider seriously the use of ureteral manipulation. Fortunately, there was no ill result in any of the four cases. We are expending more thought, however, on the future prevention of this complication. It is because so little disturbance resulted from these accidents that it seems quite reasonable to conjecture that many more are not demonstrated unless an ureterogram is taken after manipulation.

Of these four cases not one resulted from the use of any of the many instruments devised to dislodge stones. In one case an ordinary No. 7 F. catheter was used and in the three others larger catheters were passed, but only after there had been ordinary sized catheters passed in previous cystoscopies and it was felt that gradual dilatation might effect dislodgment. In only one of the four did we suspect the perforation before the ureterogram was taken. This perforation occurred just below the stone which immediately passed through the fenestra and remains encysted. The ureter has healed completely and the function of that kidney is perfect.

Why perforation of the ureter occurs is not always ascertained. One conceivable cause is a previous erosion in the ureteral wall by the stone which gives way when the stone is pressed by the catheter. In this connection may be noted 11 cases of rupture of the ureter by stone collected and described by Gordon Foulds. The rupture in these cases took place without any instrumentation whatever and might be called spontaneous. In these reported cases the symptoms were those of abscess formation which occurred in various areas along the ureteral course or in the perinephric tissue, and the striking feature was that in those which presented the gravest complications, or which ended fatally, there was found another stone below the site of

rupture which caused stasis, if not blockage, of the ureter. We believe it is because rupture in our four cases occurred below the site of the stone that so little damage ensued, as there was a free channel from the point of rupture into the bladder and, hence, no tendency for the urine to extravasate from back pressure. But the recognition of these spontaneous ruptures which occurred in the collected cases serves to emphasize strongly how easy it would be to force a stone through the already damaged ureter by even the lightest pressure of a catheter and especially by the use of a catheter of a caliber greater than the usual size.

Of the vast number of metal instruments devised to dislocate and remove stones the majority have become museum pieces, and what few remain, especially the Bransford Lewis dilator and the Howard spiral, are considered applicable only in the lowest portion of the ureter where surgery is much more difficult and where the temptation to manipulate is much greater because the stone has such a short way to go.

Another cause for the perforation of the ureter by catheter may be that the stone is checked in its downward passage by some form of stricture below it and this strictured area forms a sort of pocket into which the ureteral catheter is passed, making it much easier to perforate because the pressure is directed forward instead of laterally. Dr. Guy Hunner has emphasized the importance of stricture of the ureter, and points out that most cases of calculus in the upper urinary tract are due to stasis and that "the most frequent cause of this stasis is ureteral stricture." Since the lodgment of a stone will naturally occur at a narrowing, it is quite explicable why the stone finally lodges just above this constricted area and why, with the inflammation that we know so often occurs about an impacted stone, it should diminish even further the caliber of the canal.

These two factors, namely the erosion of the wall spontaneously by stone and the probable lodgment just above the site of stricture, taken in conjunction with the four perforations of the ureter by catheter, that we know have occurred in our cases at the point just below the stone, should emphasize the hazard of manipulation of ureteral stone. Keyes recalls that the "fundamental physiologic fact in relation to ureteral stones is that the stone advances only during periods when there is no colic or pain. The relief of back pressure when . . . (bilateral pyelostomy) . . . is performed for the relief of calculous anuria permits the silent passage of extraordinarily large stones. Conversely, manipulation calculated to irritate the ureter will, if anything, delay the passage of the stone." One of our cases particularly emphasizes this. A young man entered the hospital with the classic symptoms of ureteral colic, superimposed upon which were the signs of marked septic absorption. A calculus the size of an olive seed was seen in the upper portion of the ureter. Believing that this man would be a better operative risk if simple drainage could be instituted, a No. 7 F. ureteral catheter was passed with ease beyond the stone and after two days of drainage his septic symptoms subsided entirely. Undoubtedly the best procedure then would have

been to have performed an ureterolithotomy at once. The patient refused operation until we had made several attempts to dislodge the stone. Shortly after two instrumentations the patient again became more septic and the stone had not moved. He was given spinal anesthesia and when on the table in the Trendelenburg position the roentgenogram showed that under this relaxation the stone had passed into the lowest segment of the ureter, although half an hour previously a roentgenogram had shown it to be in the upper third.

Unquestionably the spasm of the ureter occasioned by an impacted stone, which causes contraction of the ureter due to the obstructed urine above, helps to fasten the stone in its location rather than to dislodge it. Ockerblad and Trattner have shown that morphine increases the contraction of the muscles of the ureter in direct proportion to the dosage given and that the sedative effect finally obtained from this drug is due to its action on the central pain perceptive areas rather than to diminution of the colic. The introduction of a catheter into the normal ureter will usually cause some spasmodic contraction and the relief that it does afford is occasioned by the relief of the back pressure of the kidney from drainage.

We have not included in our present tabulation of cases the number that passed their calculi without any manipulations. We have no doubt that many of those, in which our eagerness prompted us to interfere by the catheter, would have discharged themselves, and perhaps even more readily, had we restrained ourselves. Many of the favorable results that are obtained following a single manipulation are catalogued as virtues of that procedure when in all likelihood all that is accomplished is a little delay in effecting the desired result.

Discounting the large percentage of stones that pass or would pass spontaneously the problems in cases with ureteral calculi still remain diversified. Foremost is that of anuria. When obstruction occurs in a solitary functioning kidney relief must be speedily obtained. If the obstruction is low and there seems a reasonable probability of inducing the stone to pass, an attempt should be made to pass a catheter beyond the obstruction. If this should fail then surgical relief should be prompt. Just where to institute this relief depends on the patient's general condition and the accessibility of the stone. We feel that removal when the calculus is situated deep in the region of the lower ureter is an operation accompanied by considerable difficulty. In one case in our series which presented this problem we performed a pyelostomy for drainage and later when the general condition improved the stone was removed. When the stone is higher up at a more accessible area ureterolithotomy can be done with as little disturbance as pyelostomy. One very interesting type of case, which was not a true ureteral stone but in the calix of the kidney, is included in the series. Because this patient was a very poor operative risk and the stone small but causing considerable pain when the calix became distended by obstruction, the method of succussion described by Bransford Lewis was resorted to. The pelvis was lavaged with

novocaine and a solution of sterile oil introduced until the pelvis was distended. The patient, placed under the fluoroscope, was then rotated into a position that would tend to throw the stone into the pelvis. After the second rotation the stone was seen to move to the pelvic area and the patient then was placed and kept in the upright position and given atropine and morphia. In 24 hours, this stone that he had carried in the calix for four years as demonstrated by previous roentgenograms passed into the bladder.

An interesting feature of anuria where both kidneys are presumably healthy is the renorenal reflex. This phenomenon of nerve inhibition has never been quite satisfactorily explained. Here, again, effort should be made to relieve the obstructed kidney preferably by catheter, no matter where the location of the stone, as any surgery in this type of secretory dysfunction is extremely hazardous and should be undertaken only when the simpler measures fail.

The complication of ureteral stone which occasions the most concern is that with an infected kidney above the stone. Even moderate degrees of infection cannot be lightly considered because, in the presence of stasis, infection progresses rapidly and the destruction of a healthy kidney can ensue in a few days. Most of the unfortunate results from ureteral stone occur in the blockage of an infected kidney. Unquestionably, much distress has been brought about by dalliance in these cases on the one hand, and on the other, too prompt surgery has overlooked factors that will interfere with drainage even after the stone is removed. The preferable procedure under these circumstances is drainage by ureteral catheter if it can be readily accomplished. It has been our experience that there are few stones in the ureter that obstruct the passage of a catheter when the patient is thoroughly relaxed, if necessary under anesthesia. If satisfactory drainage by ureteral catheter can be obtained, the impending crisis is forestalled, and, what is more important, the function of the kidney and the condition of the ureter can be carefully studied. This may enable the surgeon to decide whether a nephrectomy is necessary, whether there is a possibility of restoring a badly damaged kidney to a serviceable state, or whether conditions in the ureter such as stricture or even distortions and enormous dilatations render radical surgery advisable. The use of intravenous urography in this connection is not usually satisfactory because the obstructed kidney may not secrete the media in sufficient quantity to enable one to visualize the outlines of the ureter or pelvis satisfactorily. Conservatism should be the slogan of urologists, but they should appreciate what is conservatism in the obstructed infected kidney is not always apparent without a careful study, and it is often as unwise to leave in a kidney capable of further devastation as it is to remove one that might be restored to normal. This judgment is difficult without estimation of the function and pyelographic studies and they cannot be made in most cases except through the use of the ureteral catheter. If we look at the obstructing stone much in the same light as we look at the obstructing prostate an analogy may be drawn. It is neither the stone nor the prostate that is of

importance; it is the damage they cause to vital structures that makes them dangerous, and we should study the conditions in those structures before we are too eager to believe that prompt removal of the obstruction will relieve all the ills that it entails.

The chief advantage that manipulation by catheter has over open operation is the hope that in stones of moderate size, the effective removal will obviate the morbidity which accompanies surgical procedure. The two deaths in these 100 cases followed operative interference, but whether they can be attributed to it or not is a question. One patient with a single kidney died from anuria four days after operation but he entered the hospital in an uremic state and relief of the obstruction did not induce the flow of urine. The second died from meningitis one month after operation although he had been up and about the hospital ten days after the operation. Both had ureterolithotomies.

CONCLUSIONS

The most important deductions we can gather from our studies of these 100 cases are chiefly confirmatory of the opinion of others.

(1) A large percentage of stones, probably more than 40 per cent, will pass without any treatment save medical relaxation of the ureter.

(2) Another 45 per cent will pass following ureteral manipulation.

(3) Ureteral manipulation even with catheters is not without danger. Frequently they cause swelling which may only increase the obstruction, and perhaps, even more often than is suspected, the ureter may be perforated. Perforation below the stone may not cause any grave disturbances.

(4) In infected kidneys where it is possible to introduce a catheter beyond the stone, indwelling catheter and lavage prior to operation is a decided advantage. This likewise enables the operator to study the function of the kidney and determine the choice of operative procedure.

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CYSTS of the testicle, excluding hydroceles of the tunica vaginalis, encysted hydroceles of the cord and those occasionally noted in the body of the testicle proper, arise within epididymal structures or vestigial remnants connected with them. We have observed 32 instances of cysts conforming in origin and site to these locations.

TABLE I
AGE INCIDENCE

Age	Number of Cases
10-20	1
20-30	2
30-40	2
40-50	7
50-60	16
60-70	4
	—
	32

The great preponderance of cases, 23, noted between the age limits of 40 and 60 is not an accurate estimate of age incidence since some of these gave a history of the presence of tumor for years before coming under our observation. Assuming that some such cystic tumors find their origin in vestigial remnants and that others are due to obstruction, there is no satisfactory explanation for their greatest incidence during midlife (Table I).

Gonorrhea is the most common cause of inflammation in the seminal tract: but only one of our patients gave such a history.

TABLE II
DISTRIBUTION

Unilateral	
Right.....	12
Left.....	15
Bilateral.....	5
	—
	32

In the bilateral cases the cystic development was coincident in four and consecutive in one (Table II).

TABLE III
DURATION

One year or less.....	11
One to five years.....	9
Five years or more.....	12
	—
	32

The rate of growth, as far as may be ascertained from the histories, has been comparatively slow in all, the duration bearing no direct relation to the

size (Table III). Some remained stationary in size, while the fluid contents in others increased in quantity and in some recurred quickly after tapping.

The rather long duration of the lesion in 21 of the 32 patients would indicate that they had suffered but little inconvenience from its presence. The symptoms in all but three consisted of the presence of a mass with or without a sense of weight: in three pain and discomfort with local evidence of inflammatory reaction the result of tapping.

TRAUMA.—Four patients gave a history of trauma with appearance of the tumor immediately thereafter: one other stated that the tumor appeared following the wearing of a truss and still another that it developed following an operation for hernia. While it is comprehensible that the inflammatory reaction induced in the tubules in and around the epididymis by trauma may prove a causative factor in cyst formation, the absence of such a history in the large majority of cases would lead to the conclusion that its occurrence may be only incidental.

SIZE.—The size was noted in 26, the smallest tumor having a diameter of one inch and the largest measuring eight by four by four inches, the remainder showing varying dimensions between these limits. The contour was noted in 22, being described as irregular, lobulated, nodular or multinodular in 12, round, oblong or oval in 7, and smooth and cystic in 3. The location of the growths as noted in the clinical examination was given in 26, being observed at the upper pole of the testicle in 16, at the lower pole of the testicle in 1, behind the testicle in 1 and described as scrotal in 8. In 18 of these 26 observations the situation of the tumor in relation to the testicle gave rather definite indication as to its character, while in 8 the consideration of hydrocele could not be excluded. Fifteen of the 32 cases showed associated lesions of hernia, hydrocele or varicocele. Inguinal hernia was present in eight cases, on the left side only in two of the bilateral cases, while in the unilateral cases it appeared three times on the same side, twice on the opposite side and once on the opposite side with an undescended testicle: in one instance a lower quadrant incisional hernia and a femoral hernia existed on the same side. One case showed a rather large varicocele of the same side and in five there was a hydrocele of the tunica vaginalis of the same side. With the exception of the latter the associated lesions are to be considered as coincidental, while in hydrocele a definite relationship may be said to exist. Six of the patients gave a history of having been tapped from one to many times, two of whom were found to have hydrocele as an associated lesion.

Twenty-five of the 32 patients came to operation, the character of the growth being unilocular in 12, multilocular in 9 and polycystic in 4; 21 were unilateral and 4 were bilateral; 3 were enclosed within the tunica vaginalis or intravaginal and 22 were extravaginal. In nine cases concomitant operative measures for the correction of associated lesions were carried out at the time of removal of the cyst; these consisted in the repair of inguinal herniae in five cases, in three of which the hernia existed on the same side as the cyst and in two on the side opposite to it; in the repair of a ventral

and a femoral hernia on the same side as the cyst; in the excision of a varicocele on the same side as the cyst; and in the resection of the tunica vaginalis for hydrocele of the same side in two cases.

OPERATIONS FOR CYSTIC DISEASE.—Twenty-six operations were done on 25 patients (Table IV), one patient returning after an interval of 14 years with recurrence of cyst formation at the site of the former operation.

TABLE IV
OPERATIVE PROCEDURES IN TWENTY-FIVE PATIENTS

Excision of cyst alone.....	12
Excision of cyst with removal of epididymis.....	4
Excision of cyst with resection of epididymis	
Upper pole.....	1
Lower pole.....	1
Excision of cyst with resection of tunica vaginalis (hydrocele).....	2
Excision of polycystic tumors of epididymis including removal of epididymis	
Bilateral.....	2
Unilateral.....	2
Orehideectomy	
Cyst and hydrocele sacs and surrounding tissues thickened by inflammatory reaction..	1
Cyst in cord back of testicle with inflammatory reaction of such degree as to interfere with blood supply.....	1
	<hr/>
	26

Pathologic Reports in Twenty-three Cases.—Polycystic disease: 4 cases, 2 bilateral and 2 unilateral. Specimens from one of the bilateral cases were unusually large, measuring 170 by 60 by 40 and 150 by 50 by 30 Mm., respectively. Of the bilateral specimens but one showed recognizable epididymal tubules, being composed of pale, pinkish-gray fibrous and serous tissue containing many simple, thin-walled cysts clumped together in masses. The cysts varied in size measuring from 2 to 40 Mm. in diameter and contained clear, colorless fluid. The unilateral specimens were similar in character. Some of the cyst walls were hyalinized, vascularized and showed lymphocytic infiltration. Some were lined by flattened epithelium and some by low columnar or cuboidal epithelium. None was found to have ciliated epithelium. The unilocular cysts varied in diameter from 25 to 100 Mm. The cyst walls were of grayish-white fibrous tissue of varying density. Some were lined with a single layer of flattened epithelial cells, some with cuboidal epithelium, while others showed complete loss of lining cells. Three showed definite lymphocytic infiltration. The multilocular cysts varied in their greatest diameter from 25 to 120 Mm. The cyst walls showed elastic and fibrous tissue. Epithelial lining consisted of low columnar, cuboidal and flattened epithelium, being wholly absent in some, partly absent in others. Hyalinization and lymphocytic reaction were present in some, absent in others.

Orchidectomy.—(1) Hydrocele and cyst walls greatly thickened: history of many tappings, repeated at short intervals. Sections of walls of cysts showed dense lymphocytic infiltration, fibrosis, infiltration by red blood cells in inner portion and hemosidering slight reaction of polymorphonuclear leukocytes. Sections of testis showed fibrosis with lymphocytic infiltration.

(2) Cyst in cord lying back of testicle with edema and matting together of adjacent tissues. Sections of cyst wall showed fibrous thickening with lymphocytic infiltration. Fluid in cyst contained many spermatozoa. Sections of testis showed fibrous tissue replacement (Figs. 1, 2, 3, 4 and 5).

The literature on cysts which develop in and around the epididymis, while rather voluminous abroad, is quite meager in this country: the paucity of articles in American literature dealing with them may be explained on the

SCHEMATIC DRAWINGS SHOWING POSITIONS OCCUPIED BY CYSTS (CROSSAN)

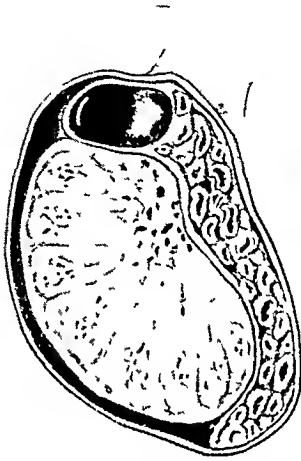


FIG. 1.—Small unilocular cyst.

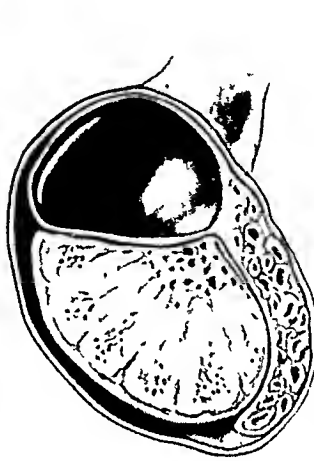


FIG. 2.—Large unilocular cyst.

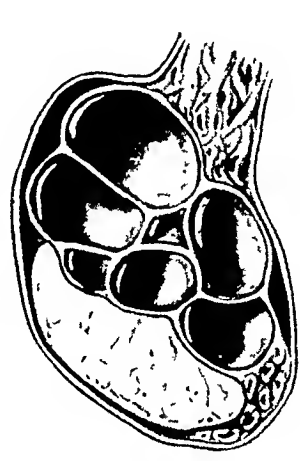


FIG. 3.—Multilocular cyst.

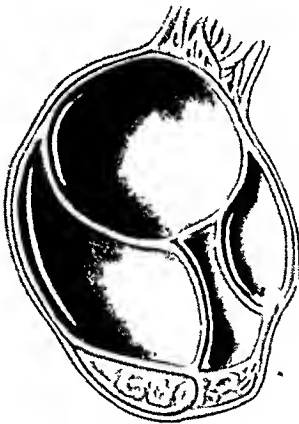


FIG. 4.—Multilocular cysts.

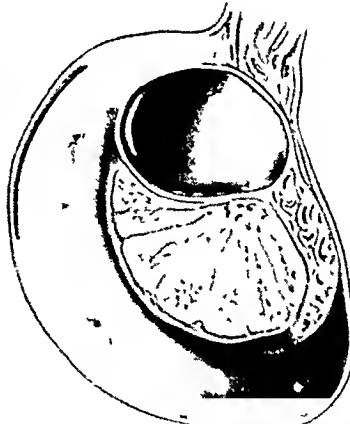


FIG. 5.—Intravaginal cyst with hydrocele of tunica vaginalis.

basis that they are either so common as to be considered of little interest, or else so rare as not to have elicited the attention their derivation warrants. An understanding of the embryologic development and descent of the testicle with a knowledge of its mature anatomy is essential to an appreciation of the possibilities of cyst formation, without however making it possible to allocate clinically every lesion to a definite origin.

From a standpoint of etiology, they may be considered as falling in three

groups: (1) Cysts having their origin in vestigial remnants; (2) retention cysts, and (3) polycystic disease or cystic embryomata. The embryologic development of the vasa efferentia and the epididymis from the mesonephric tubules of the wolffian body not infrequently results in tubular rests from failure of obliteration of excessive mesonephric tissues. The persistence of remnants of the cephalic tubules of the wolffian body attached to the head of the epididymis gives rise to single or multiple hydatids known as the appendices epididymi; the persistence of the upper end of the müllerian duct, in like manner, forms the appendix testis, both of which are known sources of cyst formation (Fig. 6). The vasa aberrantes are persistent tubules of the wolffian body, blind at one end, the other communicating with the seminif-

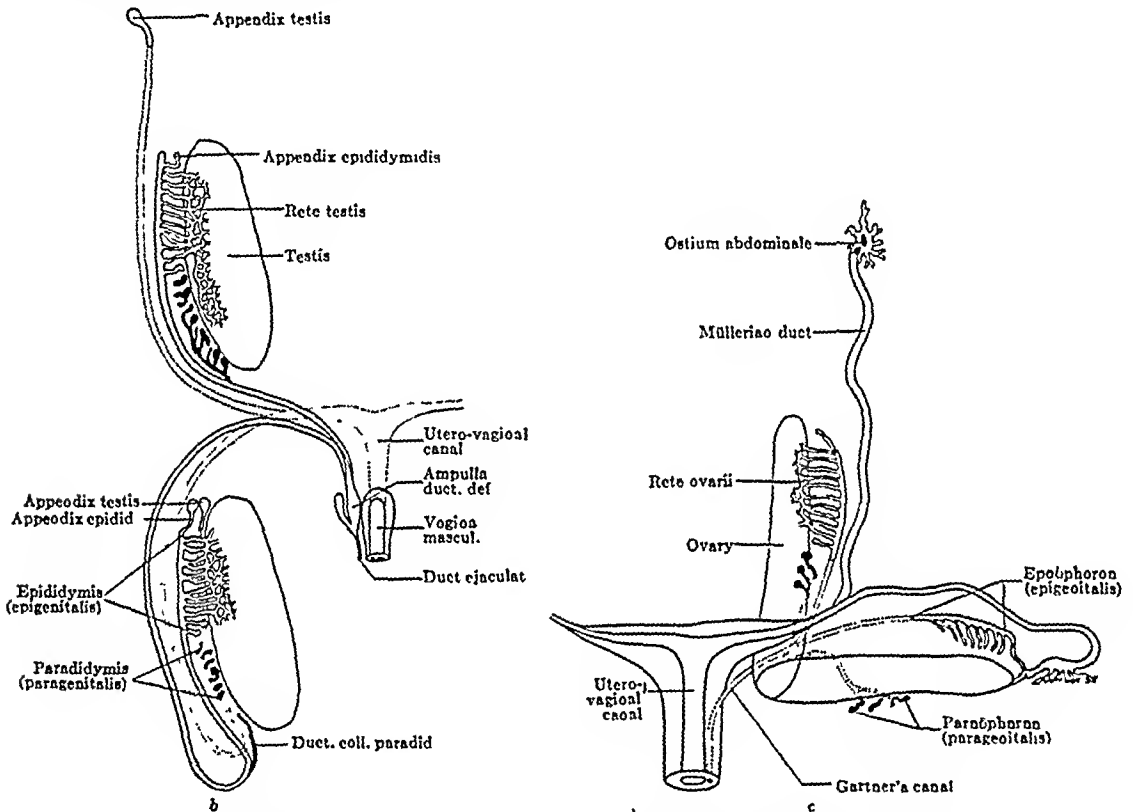


FIG. 6.—Embryologic development of testicle showing aberrant tubules forming appendix epididymis, appendix testis and paradidymis (Keibel and Mall).

erous system; the superior has its origin in the rete testis, its blind end resting in the globus major; the inferior is attached to the canal of the epididymis or the caudal end of the vas deferens ending blindly from 2 to 5 cm. up the cord. The occurrence of more than one superior vas has been described by Kobelt, being known as Kobelt's tubules. Each and all of these aberrant vasa may be the site of the cyst formation. When failure of obliteration of the caudal vesicles and tubules of the mesonephros occurs, these vestiges are found near the globus major, usually behind and above it, being known as the paradidymis or organ of Giraldès. It consists of microscopic vesicles derived from the posterior part of the wolffian body and blind, pipe-like structures derived from the lower mesonephric tubules (Fig. 6). Cysts arising in any of the above mentioned embryonic remains may retain a connection with the seminiferous system and their contents contain spermatozoa. The fluid of cysts arising in remnants without such

a connection or in those primarily possessing and subsequently losing it by closure from inflammatory reaction or pressure effects will contain none (Fig. 7).

Retention cysts develop most frequently in the vasa efferentia and least

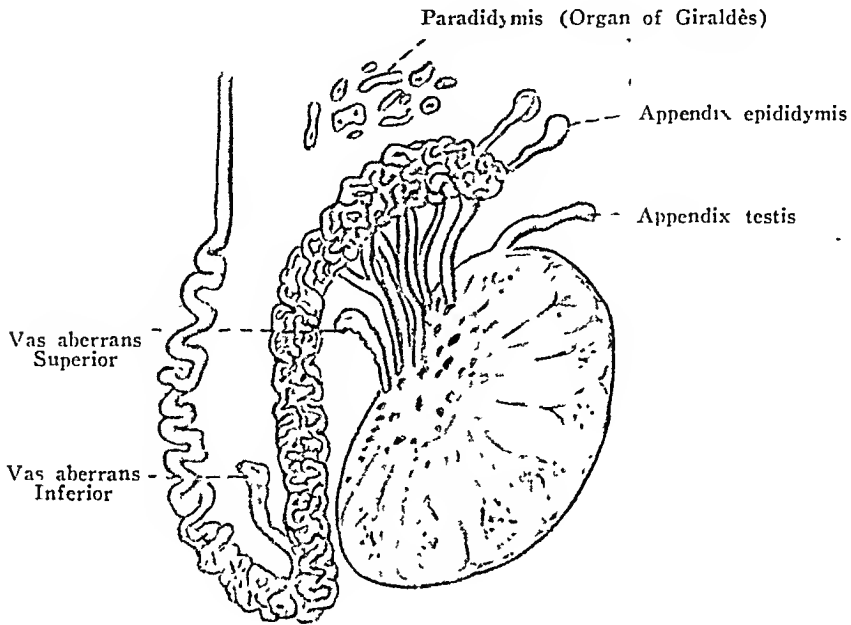


FIG 7.—Schematic drawing showing possible locations of vestigial remnants.

frequently in the *coni granulosa* of the *globus major*. Those arising from the former appear between the body of the testicle and the epididymis and may attain appreciable dimensions; those arising in the latter are usually

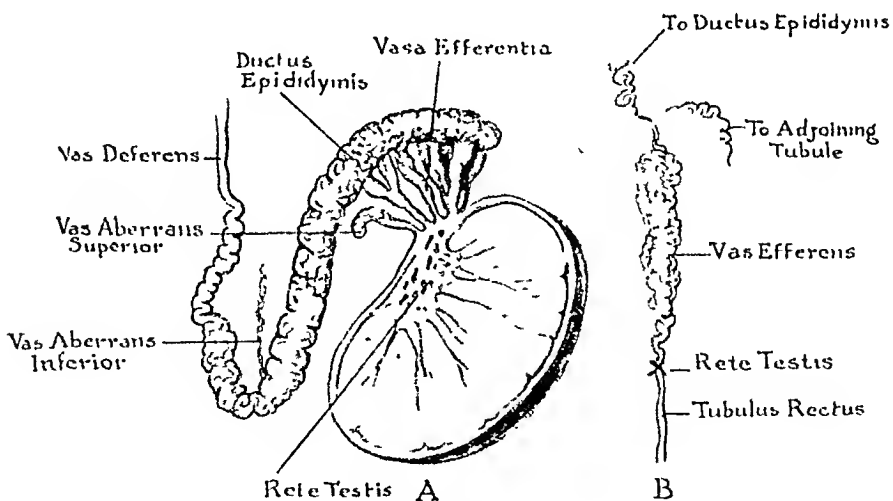


FIG. 8.—Relations of the vasa efferentia (Campbell: Journal of Urology).

small and frequently multiple. Several investigators have directed attention to the anatomic arrangement favoring cyst formation at these points. The lumen of the vasa efferentia is from two to three times larger than that of the vasa recta of the rete testis and that of the tubules of the *globus major*;

CYSTS OF THE TESTICLE

the ducts of the rete testis are supported by the firm tunica albuginea; the vasa efferentia are surrounded by loose connective tissue only. The tubules of the globus major are thin walled with a fairly firm covering, while the vas deferens is a firm, semirigid tube. Obstruction due to stricture formation as a result of trauma or infection of the ducts themselves or at a point in the seminal tract distal to the epididymis is regarded as the chief etiologic factor in the retention cysts occurring in these locations (Fig. 8).

Experimental injection of testicles under pressure has shown disproportionate dilatation of the vasa efferentia and ligation of the vas deferens has sometimes produced cystic disease of the epididymis in place of the desired atrophy of the seminiferous tubules. Retention cysts may or may not contain spermatozoa depending upon the presence or absence of a communica-

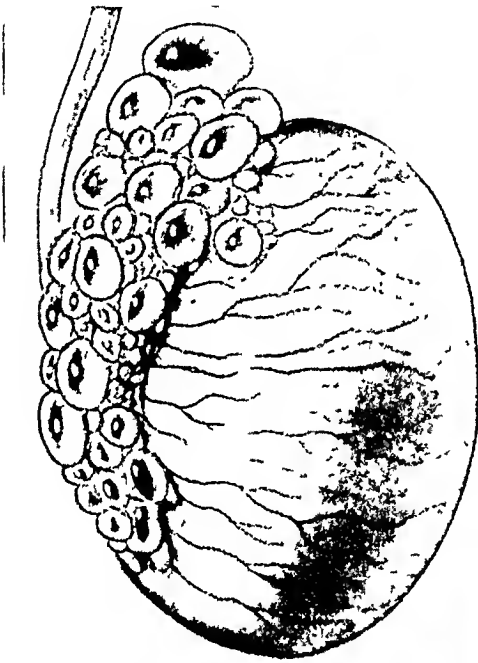


FIG. 9.—Unilateral polycystic disease of the epididymis.

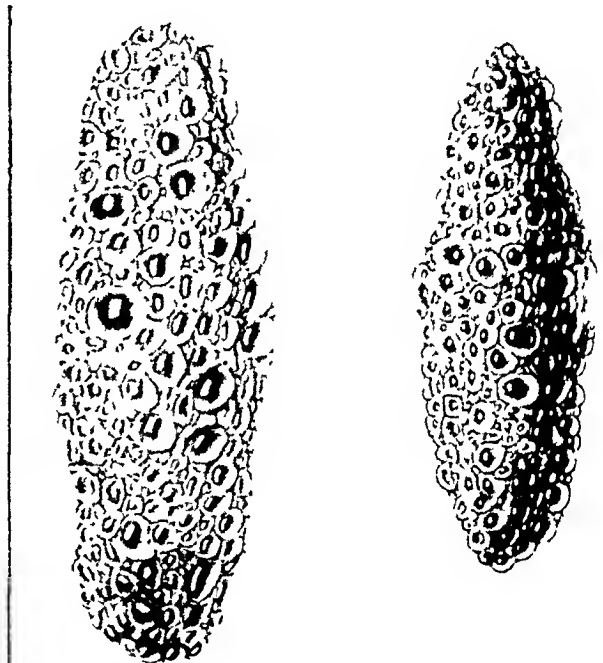


FIG. 10.—Bilateral cystic disease of the epididymis removed with preservation of the testicles.

tion with the seminal tract and upon the influence made by pressure of the cysts upon the function of the testicle. The fluid as a rule is clear and limpid but may be milky or opalescent when it possesses a high content of spermatozoa. In view of the observation that spermatozoa have at times been found in all varieties of cysts of the testicle, even in hydroceles of the tunica vaginalis, and that at times their absence has been noted in identical lesions, it is apparent that the term spermatocele but connotes a cystic tumor of the scrotum which by reason of a communication with the seminiferous system contains sperm but which does not afford information as to its origin or its location. The epithelial lining of the vasa efferentia and the ductules of the epididymis is of the ciliated columnar variety; none of the cysts in our series showed such a histology. The change in the character of the lining cells and at times their absence, in whole or in part, is assumed to be due to pressure within the cyst wall.

Polycystic diseases of the epididymis may be of limited extent conforming to the type of multiple retention cysts dependent upon obstruction, or may present the characteristics of a true neoplasm. In the latter the agglomerated cysts replace or destroy the epididymal tubules, at times attaining comparatively huge size. From their anatomicopathologic make-up they are to be classified as cystic embryomata (Figs. 9 and 10).

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DISCUSSION.—DR. FRANCIS R. HAGNER (Washington, D. C.).—It has been our experience that these solid cysts contain spermatozoa. The last type, however, usually do not. We feel that the solid cysts are congenital in the majority of cases. Regarding inflammation of the epididymis causing cysts, I think this must be very rare. I have had but one patient in about 75 that we have operated upon for sterility who had a cyst. All of these had suffered previously from bilateral epididymitis of gonorrheal origin. Thus it would seem that this condition following inflammatory disease appears to be rather uncommon. The following instance is a rather interesting one in which the spermatocele was used to good purpose. A patient at operation was found to have an occluded vas deferens on the left side and a scarred globus major with no spermatozoa. On the right side, the globus major was replaced by a moderate sized spermatocele that contained actively motile spermatozoa; the vas was patulous on this side. An anastomosis was made between the vas and the spermatocele. In six weeks actively motile spermatozoa appeared in his semen, and his wife became pregnant within two months and was delivered of a normal child.

DR. IRVIN ABELL (closing).—The fluid from the cysts of the last patient did not show spermatozoa; after the appearance of the bilateral cystic disease and before its removal he became the father of two children.

SUCCESSFUL OPERATIONS FOR HYPOSPADIAS

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THE most successful operations for hypospadias have been those in which skin flaps taken from the penis or scrotum have been used to form a skin lined canal to the end of the penis from the abnormal opening of the urethra. In general, the methods which, in our experience, have given the best results have been those of Ombrédanne, Bucknall, and Thiersch. The skin lined canal has an advantage over any other type of tubular canal in that it does not narrow or retract, and, when once established, can be counted upon to maintain a canal of constant diameter.

STRAIGHTENING THE PENIS.—Operations intended to overcome the penile curvature deformity of hypospadias should be undertaken at a very early age, preferably between one and two years. Ordinarily this correction can be satisfactorily obtained by means of transverse incisions through the fibrous cord occupying the position of the absent penile urethra, one transverse incision being made immediately in front of the abnormally placed meatus and one relatively far forward close to the glans penis, if a second one is required. It is important that the fibrous tissue occupying the position of the absent urethra be removed thoroughly and that the incisions which are closed vertically should be maintained in this position during convalescence. The patient should be seen again within a year in order to be sure that satisfactory correction has, in fact, been achieved, and if such is not the case further operation should be undertaken promptly.

METHODS OF OBTAINING SKIN FLAPS.—There are three types or degrees of hypospadias: (1) Perineal, when the abnormal opening is in the perineum; (2) penoscrotal, when it is at the root or base of the penis, and (3) penile, when it is in the shaft of the penis. The method of Ombrédanne is applicable to all three types of hypospadias, and has the advantage that the penile portion of the flap which is used to form the urethra is free from hair. The Bucknall operation, which consists of elevating a delayed skin flap from the scrotum, cannot be used in the perineal type of hypospadias; it has a field of usefulness, however, in cases in which other procedures have been unsuccessful, especially in adults when tension on skin flaps from uncontrollable erections is prevented and compensated for by the elasticity of the scrotum. After raising the skin flap from the scrotum, the Bucknall method leaves a large urethral opening at the end of the penis from which urine is likely to spray during micturition. This opening can be narrowed to advantage by using the final stage of the Ombrédanne operation. Although small fistulae practically never occur following the Ombrédanne or the Bucknall operations,

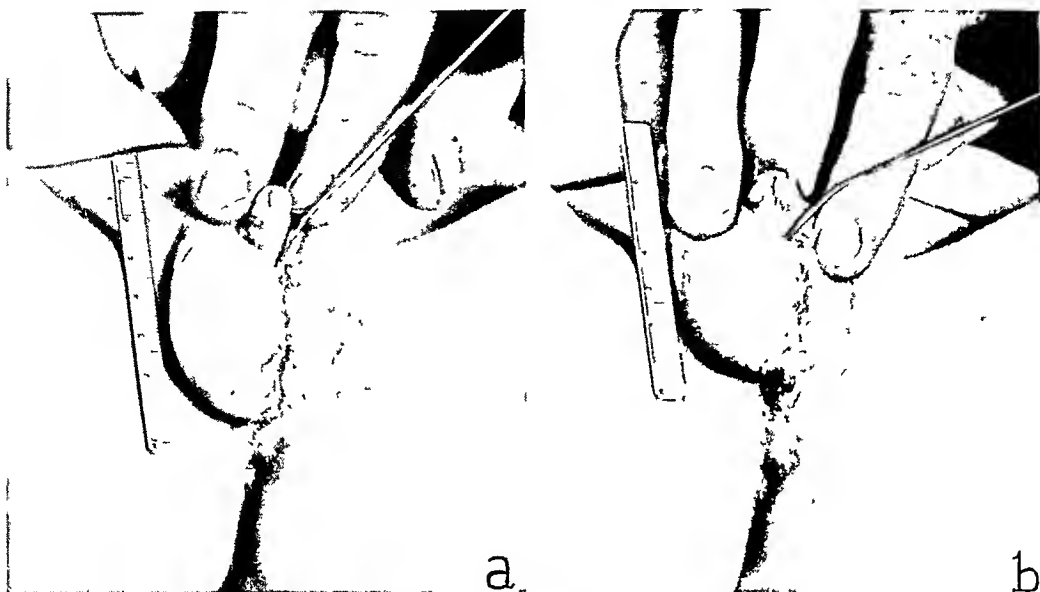


FIG 1a and b.—Conversion of a perineal hypospadias to a penoserotal hypospadias.



FIG. 2.—Conversion of a perineal hypospadias to a penile hypospadias.

Fig. 3.—Second stage of the Ombredanne operation: skin lined urethra to the end of the penis.

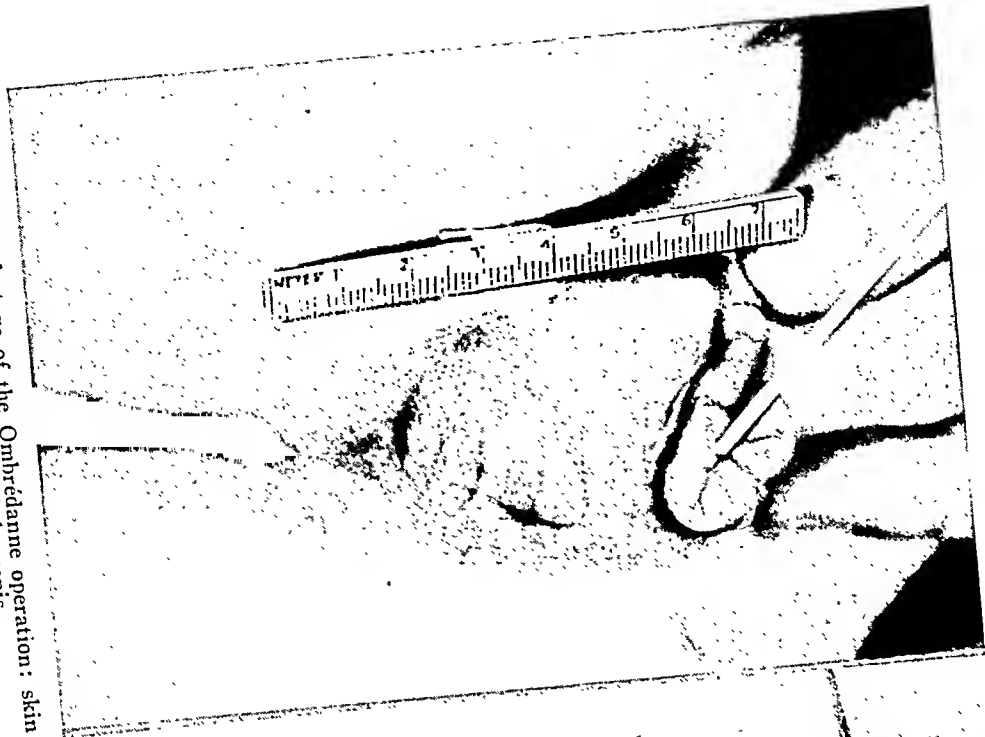


Fig. 4.—Second stage of the Ombredanne operation: skin lined urethral opening at the end of penis.

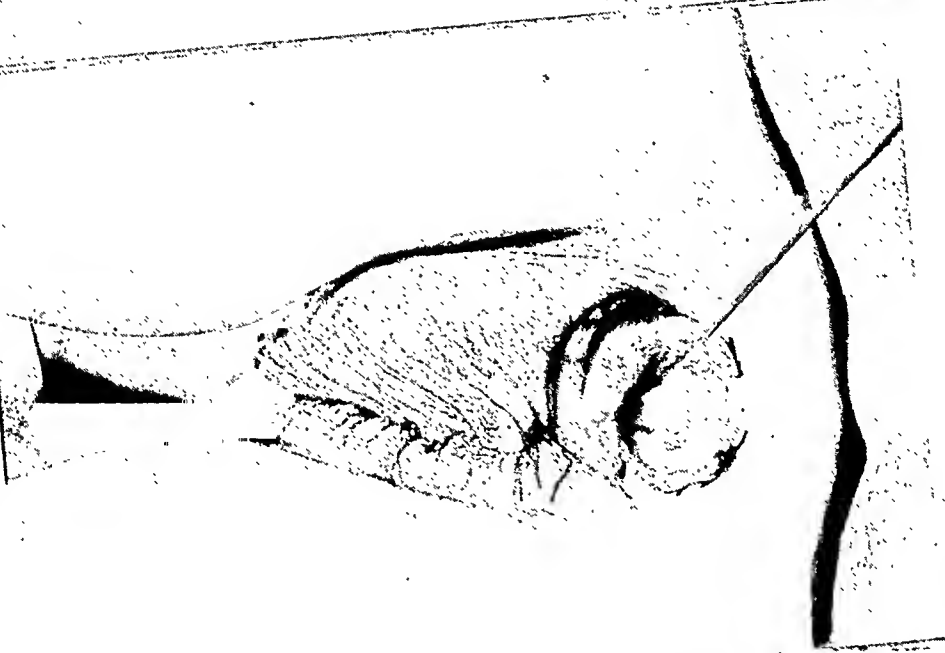


Fig. 5.—Skin lined canal opening at the end of the penis (same patient as in Fig. 3).

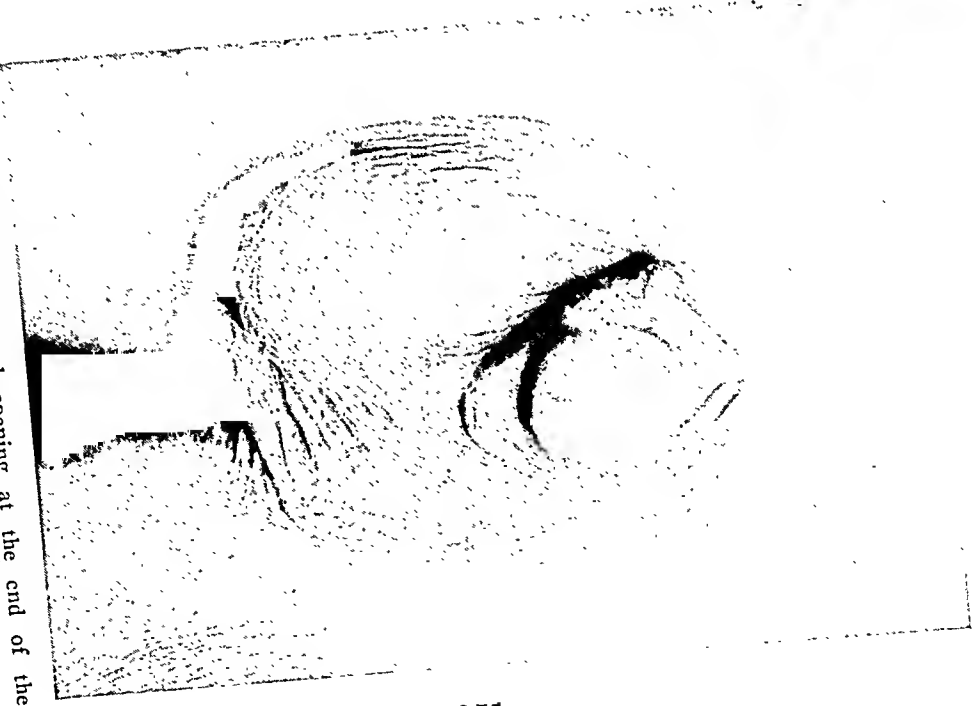




FIG. 6a.—Perineal hypospadias: Combination of Ombrédanne and Thiersch methods. Completed operation; intact skin lined canal to the end of the penis. Testes in the scrotum following the Torek operation for bilateral cryptorchidism. *b*—Lateral view.



FIG. 7.—Original penoscrotal hypospadias; skin lined urethral opening at the end of the penis.

except in cases of technical error, such fistulae can usually be closed by the method of Thiersch, taking vertical skin flaps from the penis, and folding one over the other like a double-breasted coat.

THE OMBRÉDANNE OPERATION.—The principles of treatment of hypospadias, as outlined by Ombredanne, consist in converting a perineal or penoscrotal opening to a penile opening by elevating a longitudinal skin flap from the scrotum distal to the urethral opening and reflecting it upward, covering it with lateral flaps taken from the adjacent areas of scrotum (Figs. 1*a* and *b*). It is essential that perineal hypospadias in all cases be converted to penile hypospadias (Fig. 2) as a preliminary to the main and important procedure, in which a skin flap distal to the urethral opening is reflected upward and covered by a flap taken from the foreskin, bringing the skin lined canal to the end of the penis (Figs. 3, 4, and 5). The final stage of the Ombredanne operation consists in narrowing the urethral opening and bringing it to the end of the penis by removing wedge shaped portions of skin from the under portion of the glans penis and from the upper portion of the foreskin flap, approximating these wedge shaped areas with sutures, the ends of which have been left long and brought out through the end of the urethral canal (Figs. 6*a* and *b* and 7). A period of at least two months should be allowed to elapse between each stage of the operation.

Although Ombredanne⁴ described this method of treatment of hypospadias in 1923, at which time he had used it successfully in approximately 150 cases, the method escaped recognition in America until Lyle called attention to the successful results which might be obtained by it. In 1933, he reported its successful use in nine of his cases. It has been used at the Mayo Clinic in 32 cases and excellent results have been obtained in practically every one. The operation has obvious advantages: it does not require diversion of the urinary stream by preliminary cystostomy or urethrotomy, it is apparently free from any great risk of fistula, and it creates a urethra of full length and of adequate caliber. In other words, according to Cabot, "It appears to have the advantage of being fool proof, as is the Bucknall type of operation."

THE BUCKNALL OPERATION.—In the Bucknall operation, a delayed flap of skin is raised from the scrotum, forming the anterior portion of the skin lined canal which extends from the penoscrotal or penile hypospadiac opening to the end of the penis (Figs. 8, 9 and 10). Its greatest value, it seems to me, is in cases in which other methods have failed, and this is most likely to be in those in which the patients are adults. Healing takes place without the development of a fistula because of the wide attachment of flaps adjacent to the skin lined canal and the absence of tension on the anastomosis from erections during convalescence, because of the elasticity of the scrotum (Figs. 11*a* and *b*). Cabot stated that for ten years the Bucknall type of operation has, in his experience, been the operation of choice. It, too, has the advantage of being very nearly fool proof. It seems certain that a full length canal, free from fistula, will be obtained as the result of this two stage operation. In a very few cases

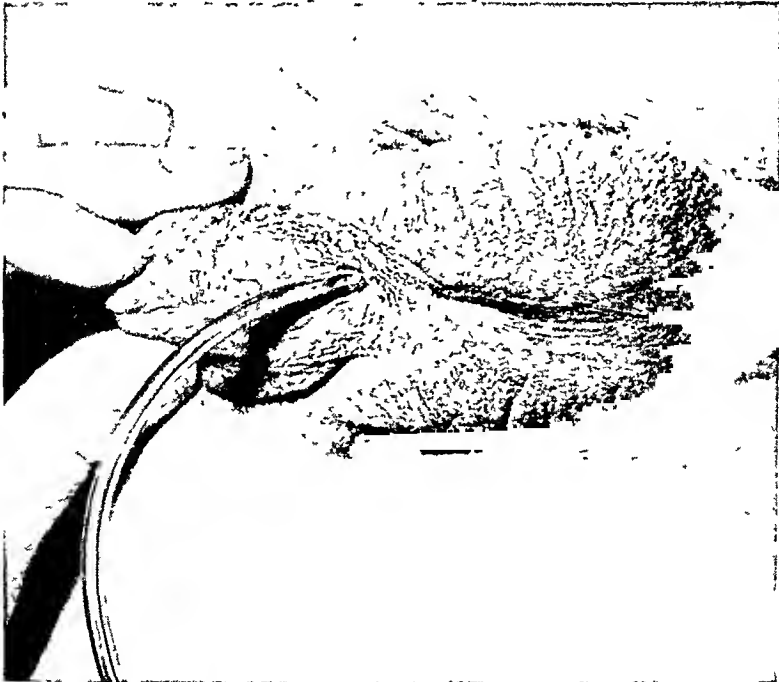


FIG. 8.—Penoscrotal hypospadias. Eight previous unsuccessful operations.

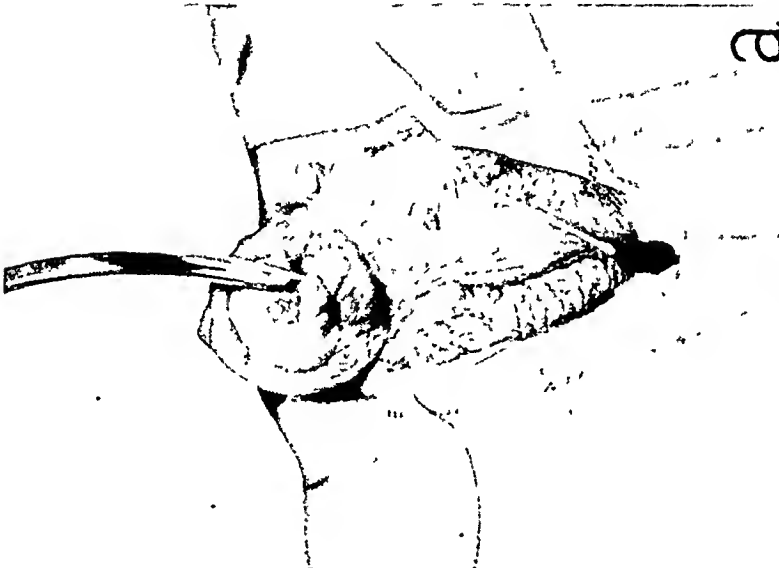


FIG. 9.—Combination of the Ombrière and the Bucknall procedures. a—Perineal hypospadias; probe points to the previous abnormal urethral opening. Skin lined canal at the end of the penis. b—Appearance dependent.

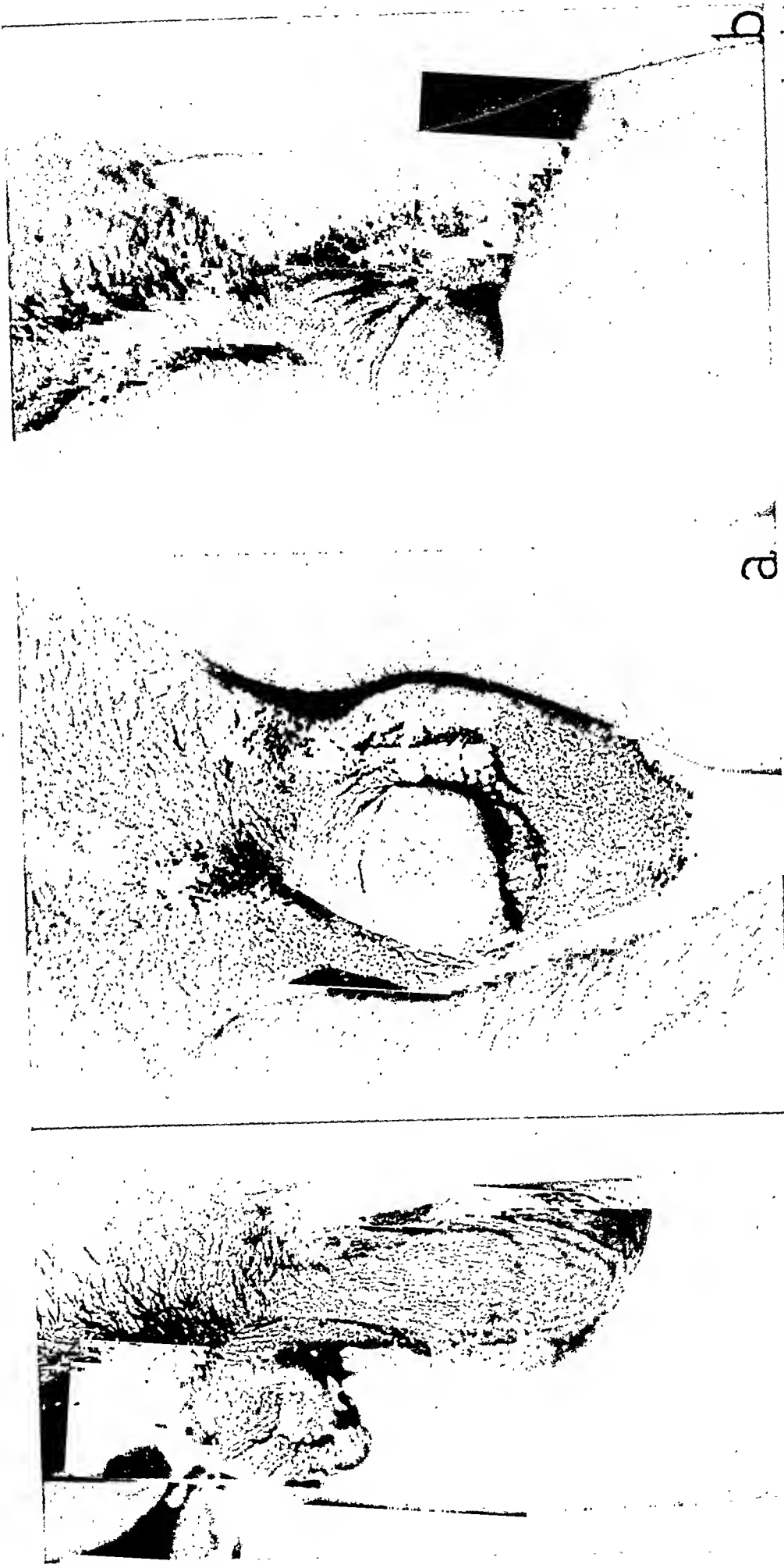


FIG. 10.—Penoserotol hypospadias. Second stage of the Ombredanne operation completed; the scrotal skin flap has been raised. The denuded area of the flap raised from the scrotum may be noted.

FIG. 11a.—First stage of the Bucknall operation; the penile and scrotal flaps sutured together. b—Appearance dependent.

urethral irritation develops from the hairs in the urethral canal, and in one case about such an area of irritation it has been reported that a stone had formed.

Although it has been suggested, because of the irritating effect of hair in the scrotal flap, that the method should have definite limitations, I believe, as stated before, that it has its greatest field of usefulness in cases in which other methods have been unsuccessful. The basis for this viewpoint is substantiated by the fact that a large number of operations of the Bucknall type have been undertaken by many individuals and since the complications just referred to were reported in the literature in only two cases, I think one can assume that such complications are rare. It may be, however, that failure to report cases

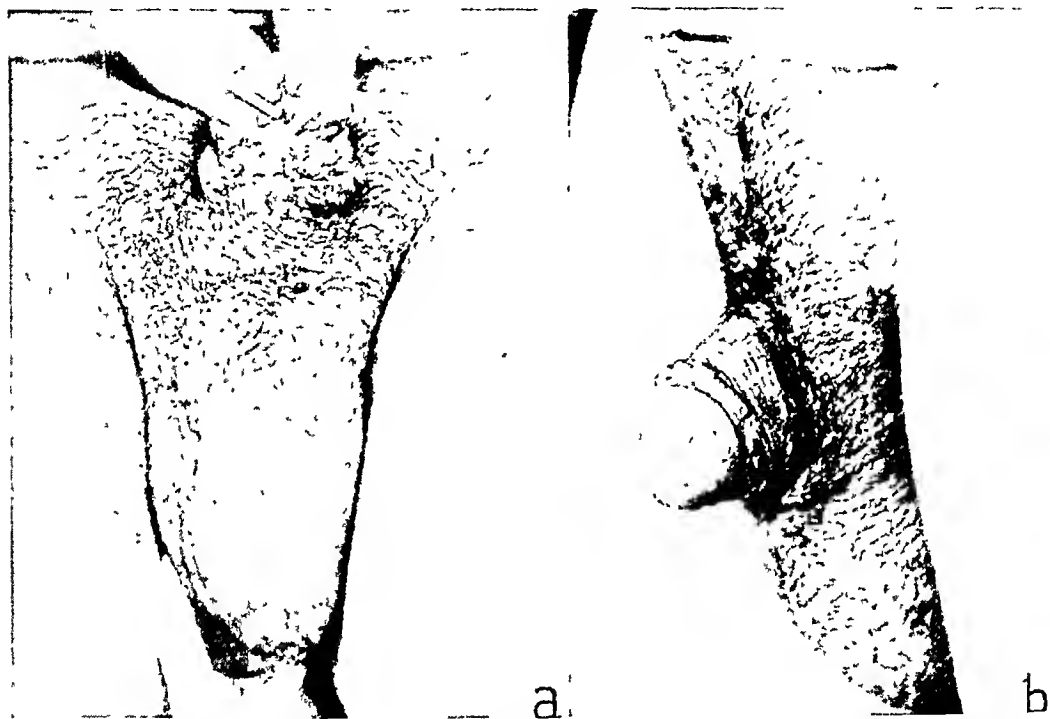


FIG. 12a.—Second stage of the Bucknall operation; the skin-flap has been raised from the scrotum. Urethra at the end of the penis narrowed by the Ombredanne procedure. b—Appearance dependent.

in which complications of this type have developed has resulted from the fact that the follow up of children operated on in childhood may have been incomplete, and the complication may, therefore, actually be more common than reports in the literature would indicate.

THE THIERSCH OPERATION.—This method in which parallel flaps are taken from the penis gives excellent restoration of the canal unless fistulae develop. It employs tissue free from hair and of fine texture which is consequently particularly well suited to its changed environment. Unfortunately, it has been characteristic of this type of operation that the formation of a fistula was a relatively common complication, requiring further operations for its repair, oftentimes with unsuccessful results. The development of such fistulae can generally be avoided by scrupulous adherence to the principles of plastic surgery, namely, union of tissue on relatively broad surfaces, never attempting

union of the edge-to-edge type, careful hemostasis, and scrupulous care in regard to securing an adequate supply of blood. With experience, the operation, in most cases, gives very satisfactory results.

RESULTS.—Various stages of the Ombrédanne operation have been used, a total of 88 times for 32 patients. It was necessary, therefore, in order to obtain a satisfactory end result to use an average of three stages. The cases were divided about equally into those of perineal, penoscrotal, and penile hypospadias. The results in 28 of the 32 cases were excellent. In the remaining four cases, after completion of the stage in which the foreskin flap was used, destruction of the flap occurred, necessitating employment of the Bucknall procedure in three instances (Fig. 12) and of the Thiersch overlapping closure in one case

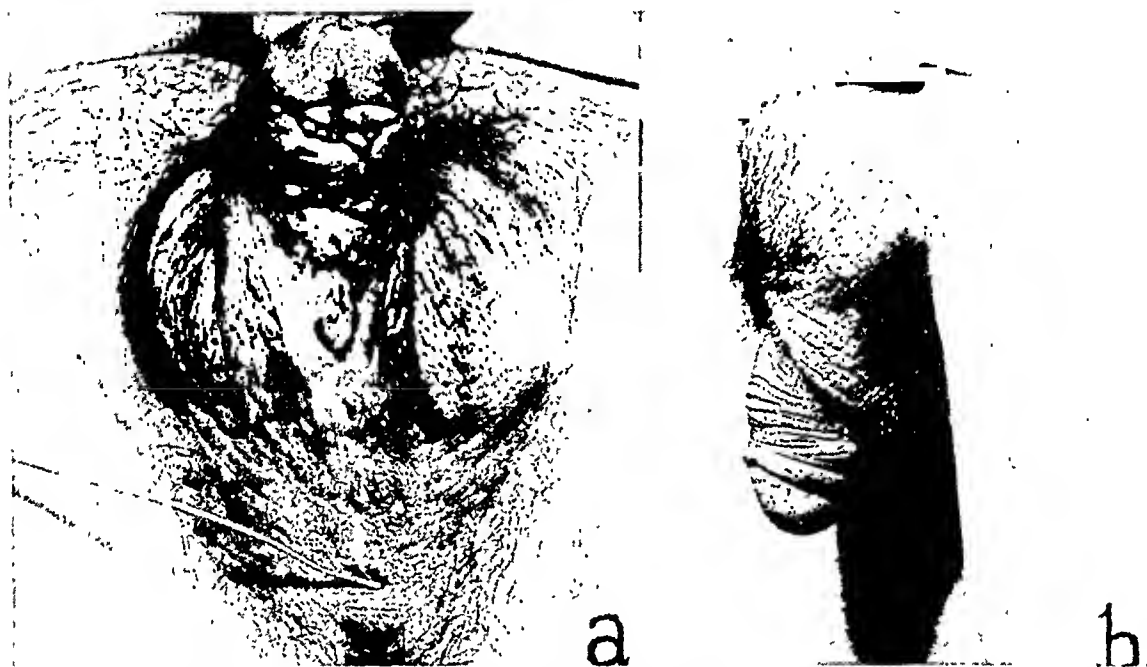


FIG. 13a.—Ombrédanne operation: *a*, perineal hypospadias; loss of continuity of the midportion of skin flaps; repair by overlapping closure of Thiersch; *b*, appearance dependent.

(Figs. 6*a* and *b*, and 13*a* and *b*) to complete the operation after the supplementary use of these procedures. In these cases good results were also obtained.

The Bucknall type of operation has been used in 16 cases, and here likewise the operation has of necessity been divided into two stages, to which has been added narrowing of the urethral orifice by the method of Ombrédanne. The results of operation in these cases were excellent but, in two of the cases, in lifting the skin flap from the scrotum, a small opening, 4 or 5 Mm. in diameter, was inadvertently made in the skin lined urethral canal; this was followed by the development of a small fistulous tract at these points, necessitating for its closure the employment of the Thiersch method later. Several of the patients who underwent the Bucknall procedure were adults, and the presence of hair in the skin lined canal was apparent in only one of them, although the others have not been followed for a sufficient time to be able to say definitely that growth of hair in the canal might not occur.

The Thiersch method and its modifications have been used in 13 cases, 46

different procedures being employed in these cases to complete the operation. These operations have for the most part been performed by Doctor Cabot, who believes that the procedure has considerable merit and has been well satisfied with the results which he has obtained from it.

SUMMARY AND CONCLUSIONS

I think it is well to emphasize the fact that all types of hypospadias are amenable to surgical treatment, and that the most effective procedures are those which enable one to extend the abnormally situated urethral opening to the end of the penis by the formation of a skin lined canal which will not contract and not deform the penis. The most effective methods for obtaining such a skin lined urethral canal have been described by Ombrédanne and Bucknall, each of which procedures has its place. When unsuccessful results have been obtained by the Ombrédanne procedure, a satisfactory result can be obtained by the employment of that of Bucknall. Should small urinary fistulae develop following either of these procedures, closure can usually be satisfactorily accomplished by the employment of the overlapping method of Thiersch.

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END-TO-END VASCULAR ANASTOMOSIS

AN EXPERIMENTAL STUDY

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IN 1759, Lambert induced Hallowell to close a wounded artery with hare-lip pins. The operation was successful. However, Assman, in 1773, found that while the suture effected hemostasis it led to obliteration of the artery by thrombosis. Arterial closure was not tried again until 1882, when Glueck in spite of numerous and ingenious experiments met with but little success. Postempski, in 1886, succeeded in closing a lateral wound of the femoral artery and thus inaugurated the modern method of suture and the first successful arteriorrhaphy in man since Lambert's case. These were, however, slits and not complete division of the vessels (Matas¹).

Circular arteriorrhaphy has been performed by Murphy's invagination method, Wietung's lateral implantation method, Payr's circular arteriorrhaphy with absorbable magnesium rings, by Horsley's broad marginal approximation, and by Carrel's technic. None of these methods has, however, been widely adopted by surgeons.

We wish to bring to your attention a method of end-to-end vascular anastomosis that we have developed in the laboratory of experimental surgery at the University of Maryland. The work has been done on dogs only, but we believe that the technic has been sufficiently perfected to allow of its use in the human.

The operation is simple to perform and does not require complicated equipment. Upon veins it has proven successful almost without exception, and upon arteries also, except when there has been too much tension upon the sutures. It is an invagination type of operation and is done over a ring of pigeon bone. We have not found it necessary to subject the raw bone to any special preparation other than boiling for the purpose of sterilization. The bone is perforated at either or at both ends by four or more holes, according to the size of the ring, and a groove or two is cut into its surface to afford a secure anchorage to a temporary encircling ligature which holds the ends of the divided vessel in apposition with each other while the permanent sutures are being applied.

OPERATIVE TECHNIC.—After exposing the vessel, the circulation is arrested by bulldog clamps (serrefines). These are applied at a sufficient distance from each other to permit of the free manipulation of the stumps (Fig. 1, No. 1). The adventitia is grasped between a finger and thumb, drawn tight and cut off at a level with the rest of the vessel. If any blood remains in the stump, it is gently stripped out and the lumen of the vessel

FIG. 1.

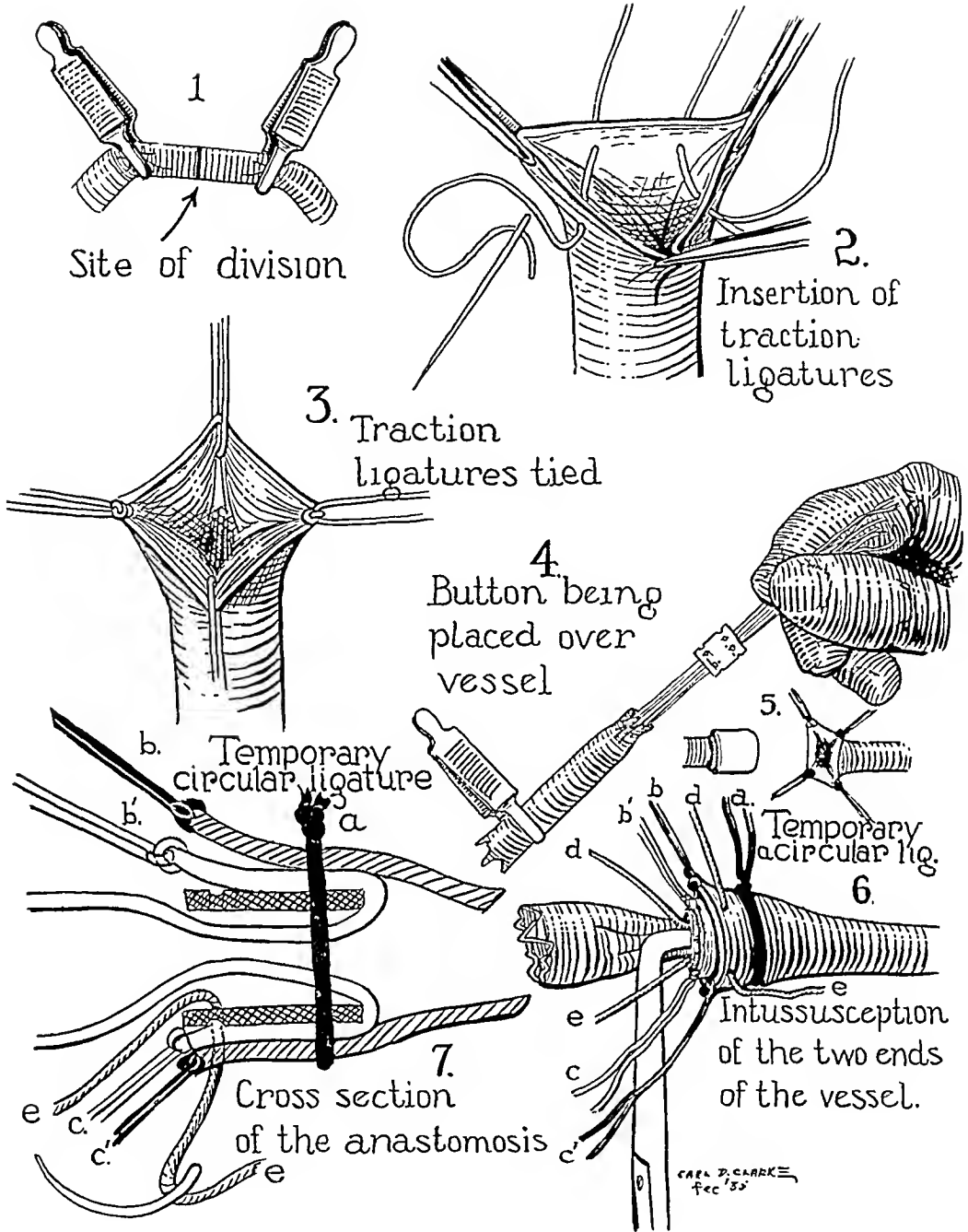
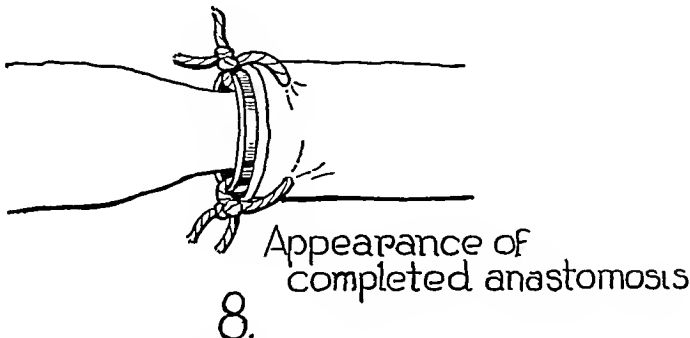
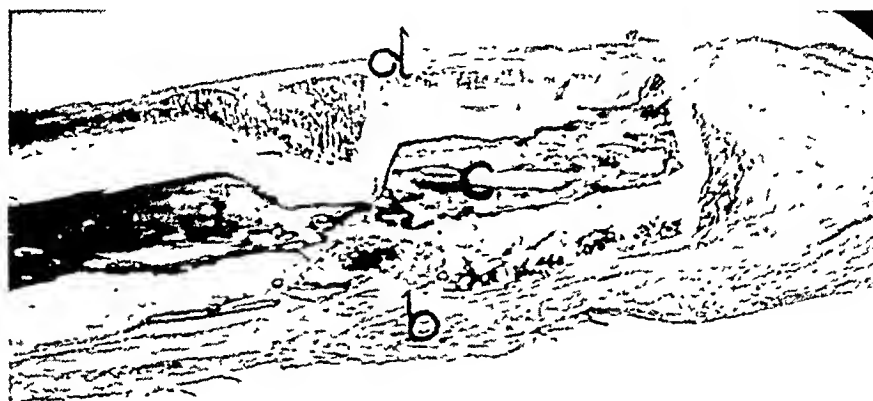


FIG. 2.



FIGS. 1 and 2.—Showing the various steps in an end-to-end vascular anastomosis.

kept moist and clean by washing with normal saline solution. The wall of the divided vessel is grasped near its open end with fine smooth mouthed pick-up forceps and four guy sutures of fine silk are inserted through the margin of the divided vessel at equidistant points (Fig. 1, Nos. 2 and 3). These sutures are tied to the edge of the vessel with a single knot, and their free ends passed through the ring of bone (Fig. 1, No. 4). The ring is slipped over the vessel and a sufficient length of vessel allowed to protrude



a.

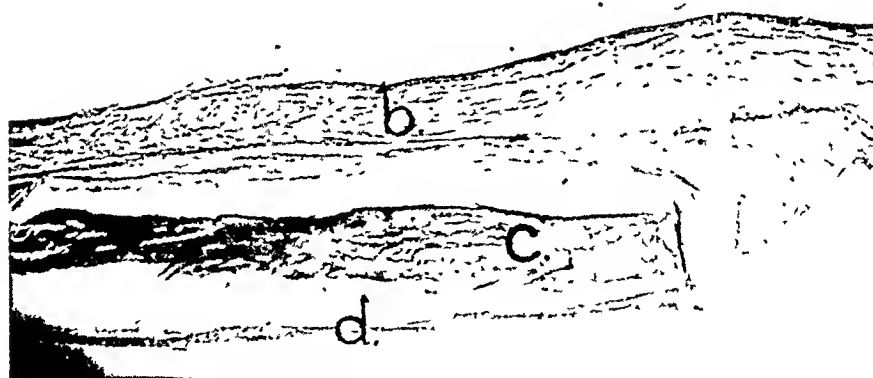


FIG. 3. (a)—Lumen of repaired vessel. (b)—Intima. (c)—Ring of bone.
(d)—Remnants of cuff.

to cover the bone. The bone is held firmly in place by a barbed holder slipped between it and the end of the vessel to be cuffed. The redundant end of the stump is then rolled back over the bone by gentle traction upon the guy or stay sutures (Fig. 1, No. 5). The end of the distal stump is now slid over the segment of vessel which houses the ring of bone, and together with the cuff is held securely in place on the bone by a temporary encircling ligature (Fig. 1, Nos. 6 and 7, a). At this stage of the operation, the circulation is reestablished by removing the bulldog clamps. The holder is also

removed. A ligature of fine silk is now introduced through each of the four holes in the ring and passed through the two ends of the divided vessel (Fig. 1, Nos. 6 and 7, d and e). These ligatures are anchored to the free margin of the ring of bone, after which the encircling ligature is removed, and the guy sutures cut away. Fig. 2 shows the appearance of the anastomosis when completed.

By this technic we have had vessels with open lumina nearly a year after being anastomosed. Fig. 3 is a photomicrograph of such a vessel showing a perfectly smooth and freely patent lumen following an end-to-end anastomosis of ten months' duration. We attribute our good results to the substitution of the four longitudinal sutures for the circular ligature, because when we depended upon the circular ligature to hold the stumps of the divided vessel in apposition until firm cicatrization had occurred, the ligature always cut through the apposed stumps and the anastomosis broke down.

In summary, we have described a method of end-to-end vascular anastomosis, which in animals has been successful, and after a year the lumen is still open. Secondly, in this method of anastomosis no foreign substance is left in contact with the blood stream.

REFERENCE

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DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Va.).—Doctor Winslow has opened up a new field in vascular surgery, and has shown quite an ingenious method of overcoming some of the objections to operations upon blood vessels. In this, as in herniae, there are different types to consider. An entirely theoretical objection to Doctor Winslow's operation is that it sacrifices a good deal of the length of the blood vessel. If, however, he is inserting a segment of a vein that objection would not obtain, and his plan would be very practical. A good many years ago I developed a technic which Doctor Winslow referred to, and which I have used frequently on experimental animals. I have had only one occasion to employ it on a human being, and that was in a cut brachial artery. The vessels are prepared in the usual way. I use sterile olive oil instead of vaseline. The sutures are brought back and forth as a double mattress suture while the ends of the vessels are held in a staff. Someone has called attention to the importance of having the blood streams turned on fully, rather than partially, to prevent clotting.

These methods are not only interesting but they are often applicable, and in the fresh wounds of arteries they are extremely valuable. In the old arteriovenous fistula they cannot be used, as the walls are thickened. I saw the patient upon whom I operated within three hours after the injury, which was just above the elbow, where ligating the artery might have been followed by gangrene.

DR. EDWARD T. NEWELL (Chattanooga, Tenn.).—Doctor Winslow's method of blood vascular anastomoses is very ingenious. I became interested in this work many years ago while visiting Doctor Horsley's clinic. As has been said, we do not have many opportunities to apply the method but they do occur occasionally. The first opportunity I had of employing Doctor

Horsley's technic was in a man who had been shot through the brachial artery, completely severing it. A perfect result was obtained. Some time later a man was slashed across the elbow with a knife, severing the brachial at its bifurcation. I ligated the proximal end of the radial artery and performed an end-to-end anastomosis, brachial to ulna, again using Doctor Horsley's technic, and obtained an excellent result.

A year or two later a boy was brought in who had been shot through the common femoral artery. An end-to-end anastomosis was performed, with excellent results. A year ago, ten years after the operation, I removed this boy's appendix, and I was interested to find that he had a good flow of blood through the femoral artery.

Quite frequently following an end-to-end anastomosis, you get an occlusion at the site of the suture, but if this does not occur at once, your blood vessels will have an opportunity to establish a collateral circulation and you will have accomplished the end you desired. If, therefore, you do not obtain a permanent patulous vessel, you have established a collateral circulation which will preserve the extremity.

ARTERIOVENOUS ANEURYSM OF THE FIRST PORTION OF THE RIGHT SUBCLAVIAN ARTERY AND INNOMINATE VEIN

REPORT OF A CASE SUCCESSFULLY OPERATED UPON

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THIS report is based on a single experience. It, however, reflects, I hope the ideals and teachings of the great master whose work has been the inspiration of whatever success is recorded here. The guiding principles as enunciated by Doctor Mataş are briefly abstracted from his Inaugural Address as President of the American College of Surgeons in 1926.

"In the presence of aneurysm, developed in one of the great arteries near the heart, we must reflect a long time before deciding to act. It is then that we should be eclectic, selecting that procedure which is most clearly indicated by the condition of the patient and of the limb."

Speaking of operating upon aneurysms he says further: "It is admittedly a serious enough matter to apply a ligature upon the innominate, or a subclavian, especially at the origin of these vessels, but the procedure, difficult as it is, is far less dangerous or risky an undertaking than to attempt to obliterate or extirpate the aneurysmal sac at the same sitting."

"We should bear in mind that in probably 80 to 85 per cent of these cases the simple occlusion of the main artery is sufficient to obtain a cure of the aneurysm. If a relapse follows, it is then time enough to obliterate or extirpate the sac."

"When operating, the surgeon should not obstinately insist upon reestablishing the continuity of the damaged artery by juggling with complicated, hazardous, uncertain and adventurous methods."

The conditions which are to be considered in this case were:

(1) We were dealing with a young man who had an arteriovenous aneurysm involving the first portion of the subclavian and possibly the innominate vein.

(2) He was tolerating well the existing aneurysm, as evidenced by the following facts—he had no symptoms indicative of general circulatory disturbance; the electrocardiographic findings were reported negative and the roentgenologic examination of the chest indicated no marked cardiac enlargement. There was, however, evidence of pulmonary disease, but tubercle bacilli were not found on repeated examinations prior to operation.

(3) There was evidence of an established collateral circulation, as the radial pulse was good and there was no muscular atrophy.

Before advising surgical interference, it was deemed advisable to consider the dangers incident to a procedure which might necessitate ligature of the innominate artery or the subclavian in its first portion.

Andrew W. Smyth, of New Orleans, was the first to successfully ligate the innominate artery for an aneurysm. Ashhurst, in 1929, stated, "Ligation of the first portion of the subclavian is in itself a serious and difficult procedure." Sherrill quotes Halsted as stating: "That the right subclavian had been ligated 12 times in its first division and that each case resulted fatally." In 1902, Matas reviewed the literature on arteriovenous aneurysms of the subclavian, at which time he stated: "Arteriovenous aneurysms of the subclavian, like those of other large trunks, persist as pathologic conditions, which are only tolerated by the organism, and remain a vulnerable point in the vascular system, which may lead—even after years of toleration—to disaster and death." He was able to collect only three that had been operated upon, and to these he added one of his own. In none of the cases was the lesion positively identified as being in the first portion of the subclavian. So far as I can find, Doctor Matas's case of arteriovenous aneurysm of the subclavian artery was the first successfully cured by operation. The operation was performed September 9, 1900.

In 1926, Doctor Matas reported 15 personal cases operated upon for aneurysm of the subclavian arteries, including four arteriovenous aneurysms of the right subclavian and two arteriovenous aneurysms of the left subclavian, without mortality and with permanent cures in all but one case. In this group the right subclavian was ligated in its first portion twice; the left, in its first division, was ligated six times. Since his results have been so much better than others, there must be something in his preparation of the patient as well as the procedures which he adopted that should be more generally appreciated by surgeons interested in this type of work.

His advice may be summarized as follows:

(1) Time should be allowed to elapse in order to develop the necessary collateral circulation.

(2) A careful study of the effects of the existing arteriovenous fistula on the heart should be made.

(3) The presence of cardiovascular disorders "is the best indication and urge for surgical interference, with a view of obliterating the communication as a means of restoring the normal balance of the circulation."

On the first cardinal principle there is little discussion—the necessity for delay that collateral circulation may develop for the preservation of the limb.

The value of recent innovations such as the Pavaex treatment by Herrmann and Reid may be expected to aid in the rapid development of collaterals.

The sequence of cardiovascular phenomena which follows arteriovenous fistula has been a fertile source of controversy and inquiry since Halsted's observations were made in 1918. Halsted stated, "A particularly interesting result of our clinical and experimental studies of arteriovenous fistula is the discovery that enlargement of the heart probably occurs after a time, as a rule, in the major cases. My attention was forcibly called to this complication some ten years ago by a case of fistula of the femoral vessels which

I saw in consultation with Dr. James F. Mitchel. Since then we have more carefully noted the condition of the heart in our cases of arteriovenous aneurysm and have, I believe, quite invariably found it enlarged, strikingly so in several instances."

In 1923, Matas stated that 70 per cent of the cases of arteriovenous aneurysms operated upon by him presented cardiovascular disturbances. Prominent among these changes were enlargement of the heart, murmur, tachycardia and dilatation of the artery proximal to the fistula.

Reid, Holmann, Reinhoff, George Herrmann and Gage and others have contributed much experimental evidence to clarify the sequence of these cardiovascular changes which elder clinicians had noted where an arteriovenous fistula is present.

It may be well to abstract briefly Holmann's conclusions:

"The remote effects following the production of a fistula are:

"(1) A permanent diversion of part of the blood volume from the circulatory system of heart-artery-capillary bed-vein into the second circulatory system of heart-artery-fistula-vein.

"A gradual dilatation of the heart, and of the artery and vein proximal to the fistula, to accommodate this increasing flow of blood through the fistula.

"A hypertrophy of the heart due to the increased work necessary to propel forward this increasing volume of blood flowing through it.

"The closure of an arteriovenous fistula should theoretically produce the reverse of all these changes, and experimentally as well as clinically this has proved to be the case.

"The remote effects following repair or excision of a fistula are:

"(1) A gradual readjustment in the general blood pressure, the systolic falling to a level approximately the same as that before elimination of the fistula, the diastolic remaining at a higher level than that present with the fistula open. The result is a decreased pulse pressure as compared to that present with the fistula open.

"(2) A slow recovery to the normal rate of a pulse retarded by repair of the fistula.

"(3) A gradual decrease in total blood volume, the real cause of the gradual fall and adjustment in blood pressure noted above.

"(4) A gradual subsidence of the dilatation of the heart, and also of the proximal artery and vein, proceeding *pari passu* with the decreasing volume of blood flowing through them."

Herrmann and Gage stated, as a result of their experimental work, that "In the presence of an arteriovenous fistula between the carotid artery and jugular vein, we have confirmed the observation of an immediate enlargement of the cardiac shadow as the fistula is opened. This we feel can be nothing other than dilatation of the heart as a result of the blood shunt. Thus, one of the primary factors in this condition seems to be cardiac dilatation."

Mont R. Reid states, "The effect of arteriovenous fistula on the heart

is now well known, and numerous cases, in which a dilated and hypertrophied heart has practically returned to its normal condition following the cure of a fistula, have been reported."

In a paper, Doctor Matas, in 1923, writing of his earlier experience, states, "The prospect of curing the heart disease by suppressing the fistula has not yet dawned upon the profession as an indication for surgical action."

Confirming, with his clinical experience, the data obtained by laboratory experiments made by others, he stated, "In the majority of long standing cases (14 patients) the main artery proximal to the fistula was notably enlarged.

"The results of these operations prove conclusively that the more or less disabling cardiac and circulatory disturbances which existed in these cases prior to the operation were due to the systemic effects of the arteriovenous fistula, since in all of the recovered patients the suppression of the fistula was followed promptly by permanent symptomatic relief."

All available clinical and experimental data then, are warrant for the operation, if the patient with an arteriovenous aneurysm is properly prepared and the surgeon tries to safeguard the patient by any and all available measures.

The danger of gangrene from inadequate collateral circulation can now be obviated in a measure by the use of the Pavaex treatment as suggested by Herrmann and Reid.

CASE REPORT

Mr. T. R., aged 30. Admitted to Charity Hospital October 22, 1934. About 18 months prior to admission he was stabbed in the right side of the neck. Within one hour of the accident he was brought to the hospital, where his wound was considered of minor importance. Following the healing of this wound he suffered no inconvenience as it did not interfere with his ordinary activities. His reason for applying for admission to the hospital in October, 1934, was the existence of external hemorrhoids and it was only during the examination by the intern, Doctor Schaible, that evidence of an arteriovenous aneurysm involving the subclavian was found.

My attention was called to this patient and the following is a record of the examination made on November 1, 1934.

Examination.—On inspection the patient is well nourished. Pupils equal, react to light and accommodation. No exophthalmos. No widening of the palpebral fissure. No evidence of lagophthalmus. No ptosis. No lack of convergence. Patient is able to move the globe in any direction. No evidence of extra-ocular motor paralysis. No loss of symmetry of the face.

Neck: No loss of symmetry of the neck. There is a scar on the right side of the neck just lateral to the attachment of the sternomastoid. Pulsation in both sides of the neck, about the level of the hyoid, apparently identical. No marked suprasternal pulsation. Supraclavicular spaces almost identical, if anything the one on the right seems to be a little bit deeper than on the left side.

No difference in the contour of the shoulders, possibly the right is slightly larger than the left. Both forearms about the same size and the color is almost identical. If anything the right palm has a greater red flush than on the opposite side. No suggestion of atrophic changes, neither thenar nor hypothenar spaces. Both hands are moist. Both radial pulses good, full and easily compressible. The vessels feel as though they are

the same size. Brachial artery on the right side is easily palpable, full, bounding and compressible.

On palpation of the right side of the neck there is a definite thrill imparted to the examining fingers. The maximum intensity of the thrill is in the supraclavicular space just over the region of the scar. It loses its intensity as we palpate medial or lateral to the scar. The thrill begins to lose in intensity upward about one-half inch above the level of the scar. The thrill is not palpable or noticeable below the clavicle.

Chest is symmetrical. No bulging of the costal spaces. Veins not prominent. Slight diminution of percussion resonance about one inch medial to the nipple line. No murmur, although there is a slight bruit heard. This begins to increase in intensity as we approach the second interspace on the left, becoming very loud when we approach the second interspace on the right, just below the clavicle and over the upper portion of the sternum it is a definite roar. Above the clavicle the sounds are like a "steam boat trying to make a landing, not only the noise of the engine, but the splashing of the



FIG. 1.—Roentgenogram showing presence of caseous bronchopneumonia in right apex, and apparent normal size of the heart.



FIG. 2.—Roentgenogram two and one-half months postoperative, in which the heart shadow is definitely smaller than in Fig. 1. Indicating that the heart had been enlarged primarily, as a result of the arteriovenous fistula.

waves, it is a whirring sound." It loses its intensity as we go up the neck on the right side, although it can still be heard just below the tip of the mastoid.

There is a scar of a previous stab wound one inch medial to the suprasternal notch and along the belly of the sternomastoid. Marked pulsation is noted in the right supraclavicular and along the course of the right common carotid. Bruit heard, loud.

The bruit and thrill can be controlled and stopped entirely by pressure in the supraclavicular space close to the sternal end of the clavicle. Controlling the bruit and thrill, however, does not cause a cessation of the pulsation in the carotid or in the radial pulse. When pressure is not made over the supraclavicular region, the bruit can be heard over the back down to about the fourth dorsal vertebra. It is loudest on the right. The bruit is heard very loudly over the entire right side of the chest anteriorly and on the left side almost equally as loudly down to the fourth interspace in the nipple line, particularly loud over the ensiform cartilage. Closure of the fistula by pressure does not produce a Branham phenomenon (slowing of the pulse).

Upper extremities reveal no atrophy of either arm. No change in the color of the fingers. No loss of grip.

Blood pressure, right arm, 98/50. There is a slight rise possibly four to six points in systolic pressure when the carotid is obliterated. Left arm, practically the same findings, with no more variation in the systolic pressure than on the right side.

The following roentgenologic reports were submitted as part of the record which had been made.

October 23, 1934: View of chest shows an extensive caseous bronchopneumonia of the upper lobe of the right lung and peribronchial and vesicular involvement in the upper portion of the left lung. There is no evidence of enlargement of heart or dilatation of the aorta (Fig. 1).

Roentgenograms taken after operation indicate that there was indeed a definite enlargement of the heart which was secondary to the fistula (Fig. 2).

October 30, 1934: View of the chest shows no dilatation of the heart or aorta. There is a bronchopneumonic process about the upper lobe of the right lung with evidence of fibrosis and areas of active vesicular involvement. The right leaf of the diaphragm is elevated and there is thickening of the pleura in the costophrenic angle. The upper portion of the left lung shows few bronchial infiltrations with areas of vesicular involvement.

Wassermann negative. Sputum negative for acid fast organisms. Hemoglobin 90 per cent.

Blood pressure on November 18, 1934; right arm, 96/34; left arm, 92/32. On November 22, 1934, blood pressure was 108/50.

The impression was obtained that we were dealing with an arteriovenous aneurysm, probably between the first portion of the subclavian artery and the subclavian or innominate vein. Realizing that the operative procedure was a hazardous undertaking, and further, that the patient was not then conscious of the trouble, and further that the collateral circulation was efficient, and lastly that there were no evidences of cardiac disturbance, it was decided to prepare the patient over a long period of time by compression of the main blood supply to further improve collaterals in the event that ligation or other means of obliteration of the subclavian became necessary. For that reason, daily pressure on the carotid and the axillary was done and on November 25 the patient was permitted to leave the hospital with instructions to return for observation and operation if symptoms arose.

On March 11, he returned for observation. At this time he complained of weakness in his right arm and since he had not been permitted to work he wanted to be operated upon with a hope of being cured if possible.

Examination at this time revealed the scar of the previous stab wound one inch medial to the suprasternal notch and along the belly of the sternomastoid. Marked pulsation in the right supraclavicular and along the course of the right common carotid. The bruit was loud and presented the same characteristics previously described.

The bruit and thrill could be controlled and stopped entirely by pressure in the supraclavicular space close to the sternal end of the clavicle. Controlling the bruit and thrill, however, did not cause a cessation of the pulsation in the carotid or in the radial pulse. When pressure was not made over the supraclavicular region, the bruit could be heard over the back down to about the fourth dorsal vertebra. It was loudest on the right. The bruit was heard very loudly over the entire right side of the chest anteriorly and on the left side almost equally as loud down to the fourth interspace in the nipple line, particularly loud over the ensiform cartilage. Closure of the fistula by pressure did not produce a Branham phenomenon. Examination of the upper extremities revealed no atrophy of either arm. No changes in the color of the fingers. No loss of grip.

He was readmitted to Charity Hospital on March 13, 1935, and a roentgenogram taken at that time showed slight enlargement of the cardiac shadow. The pulmonary condition showed slight progress of the disease.

Operation.—March 18, 1935. Preoperative diagnosis: Arteriovenous aneurysm, the

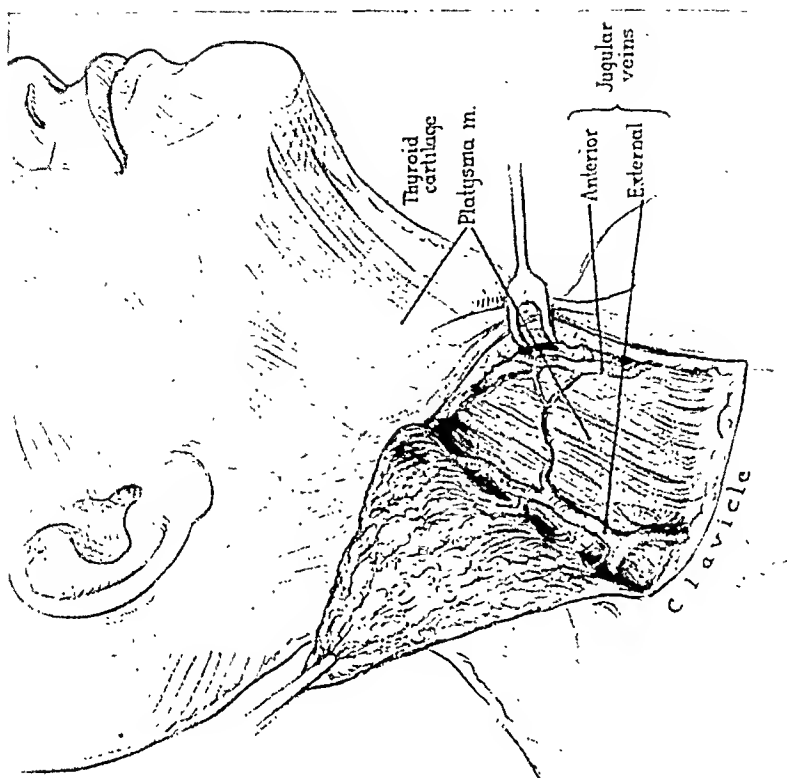


FIG. 4.

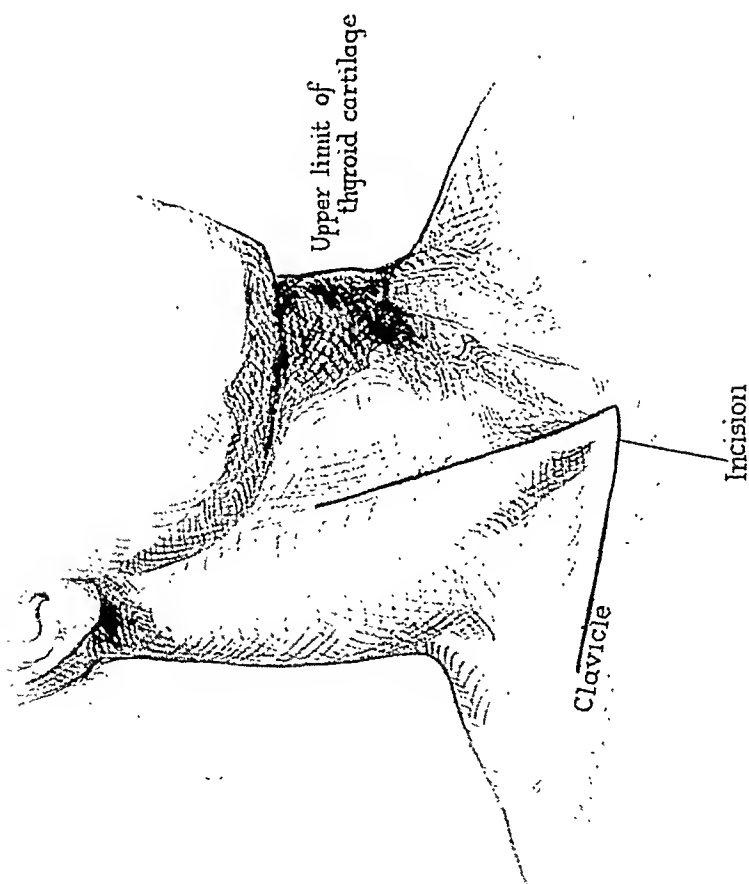


FIG. 3.

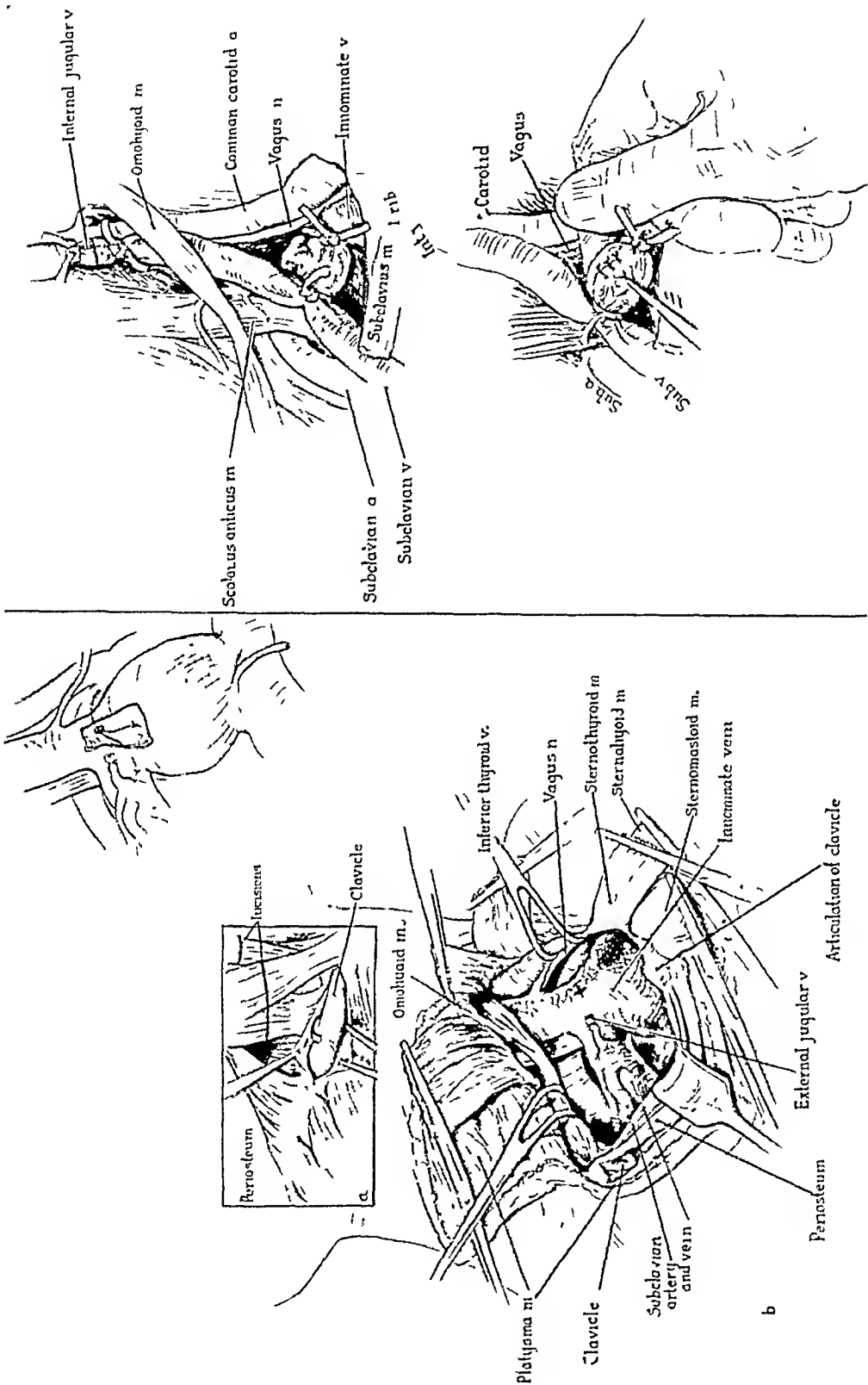


FIG 5.

FIG. 6.

Figs. 3, 4, 5, 6 and 7.—Drawings illustrating the operative steps of the procedure elaborated in the text; and the appearance of the anatomy as it was exposed.

fistulous communication probably being between the first portion of the subclavian artery and the subclavian or innominate vein. The location of the fistula at this point was suggested particularly by the fact that obliteration of the fistulous opening and stilling of the bruit and thrill caused a diminution in the size of the radial pulse but did not interfere in any way with the common carotid pulsation in the upper portion of the neck.

An incision was made along the anterior border of the sternomastoid, the upper limit being the upper limit of the thyroid cartilage, and extending down to the sternoclavicular articulation. A second incision was then made over the clavicle from the sternoclavicular articulation outward for about two-thirds of the length of the clavicle (Fig. 3). This is the old Valentine Mott approach. The flap was dissected back so as to expose the anterior jugular vein, lying on the platysma and the external jugular veins posteriorly (Fig. 4). The incision was deepened so as to expose the anterior border of the sternomastoid muscle. After it was exposed and retracted the internal jugular could be seen.

The incision over the clavicle was deepened so as to expose the clavicle itself. Its periosteum was incised and the clavicle separated from the periosteal covering in its inner two-thirds (Fig. 5).

The sternomastoid muscle was then sectioned between clamps and the upper portion of the belly reflected upwards. The clavicular portion reflected down. We then could see the omohyoid crossing the carotid artery and jugular vein. The sternohyoid and sternothyroid muscles were sectioned between clamps and reflected upward and downward as had been done with the sternomastoid muscle.

The clavicle was not subperiosteally removed before sectioning the muscle because it was felt that that would diminish the plane between the muscle and vessels and would have made section of muscles more hazardous, so far as the vessels were concerned.

We next sectioned the clavicle with the Gigli saw at the junction of the middle and outer third (just medial to the attachments of the trapezius). At its sternal attachment it was disarticulated. We were then able to introduce retractors so as to expose the vessels in the depths of the wound. At this point we could see the carotid, pneumogastric nerve, and jugular vein and the omohyoid crossing these structures. Below the omohyoid we could see a small circumscribed prominence which was pulsating (Fig. 5), the level of this corresponding to a point just medial to the scalenus anticus. With the finger over this pulsating mass it gave the characteristic thrill which had been felt preoperatively, and pressure over it obliterated the thrill completely. The origin of the subclavian artery from the innominate could not be seen at this point. The jugular vein in its descent over the subclavian artery to join with the subclavian to form the innominate vein interfered with exposure of the fistulous communication. The jugular was then ligated above the omohyoid muscle. An attempt was made to retract the innominate vein so as to expose the first portion of the subclavian proximal to the arteriovenous fistula with a view of being able, if possible, to put a tape for temporary obliteration of the subclavian artery before going into and trying to clamp the fistulous communication. I expected to be able to put a similar tape on the third portion of the subclavian. The innominate vein and subclavian and the fistulous communication into the artery were so closely and intimately inherent to the scalenus anticus muscle that in an effort to separate and find a line of cleavage an opening was made into the aneurysm sac and there was an immediate gush, not a spurt, but a steady flow of blood. I was, fortunately, able to control this by putting my finger underneath the subclavian artery in its first portion close to the scalenus. There seemed to be no other way of controlling this at the time than by putting ligatures proximal and distal to this opening into the aneurysm sac. For that reason, with a ligature carrier I passed braided silk around the artery and vein, and tied them both off, thus ligating together the subclavian artery and the innominate vein just at the point where the subclavian vein and the jugular unite to form the innominate vein (Fig. 6). There was still a small amount of bleeding and for that reason three sutures of fine catgut were intro-

duced to act as obliterative sutures (Fig. 6). This effectively controlled the bleeding. When the field was clear we were then able to see the first portion of the subclavian proximal to the ligature and also see its point of origin from the innominate. Evidently the reason we could not see it prior to this time was due to the aneurysmal dilatation of the innominate vein. We encountered some additional bleeding which I believe was due to a wound in the transverse scapular vein or the external jugular at its entrance into the subclavian. The vessel was doubly ligated and all bleeding was then controlled.

At one stage of the operation there was a slight hissing sound, suggestive of an injury to the pleura or possibly some bleeding into it, from an injury to one of the venous channels. After the last procedure there was no longer such sound, and the patient's respiration did not seem to be interfered with.

The muscle planes were reconstructed, the sternohyoid, sternothyroid and sternomastoid approximated with mattress sutures and the wound was closed without drainage (Fig. 7).

It was noted during the operation, and immediately following, that the hand and arm on the right side had a light purplish hue. The arm was encased in a copious dressing of cotton, a blanket placed on top, in an effort to make a mattress dressing as suggested by Doctor Matas.

Patient was given an infusion and later in the day a transfusion of 500 cc. of whole blood.

The following is an abstract of the progress notes made by Doctors Hantmann and Schuster.

The color of the right hand and arm improved somewhat over that noted at close of operation. Whole extremity wrapped in cotton batting and blanket and placed under a heat tent.

The highest temperature on March 18 was 102°. Pulse 84, respiration 32, 8 P.M. On March 19, the temperature reached 104°, pulse 104, respiration 30. Blood pressure 126/80. Patient has difficulty with respiration at times.

Percussion note over entire right chest anteriorly is dull, breath sounds over same area are faint, with a few scattered moist râles. Left anterior chest negative.

On March 19 the right arm was cold, of slight purplish hue. No radial pulse was present.

On March 20 the appearance of the arm about the same.

March 24, 1935: The arm feels warm, the color is good, there is no disturbance of sensation and movement of the fingers, elbow and shoulder are excellent. Veins in the upper inner aspect have thrombosed feel. The patient still has pain though not as severe as before. Blood pressure 118/70.

March 28, 1935: Wound healed by primary intention. Slight fulness of supraclavicular region, and discoloration of the tip of the flap. All sutures except one at the angle removed. No discharge from wound. No bruit or thrill present. Patient is able to raise his arm well above the right angle. Very little, if any, difference in the color of the two hands. The arm feels warm, as does the hand. The hand is moist. He complains of some soreness of the arm on the inner aspect of the biceps muscle, along the course of the brachial artery and vein. No pulse at the wrist.

April 2, 1935: Electrocardiogram showed "P.R., 0.14; Q.R.S., 0.08 sec. Rate: Auricle 81, ventricle 81. No significant change from previous electrocardiogram. No electrocardiographic abnormality."

April 17, 1935: The arm is of good color, sensation normal, motility good. Wound healed. No bruit or thrill present.

April 18, 1935: Wound healed. There is no marked pulsation in the neck noticeable. The right clavicular protrusion is not so prominent as the left. (The inner third of the clavicle was removed at operation.) The infraclavicular space is more marked on the left than on the right, and the axillary fold on the right is more prominent than

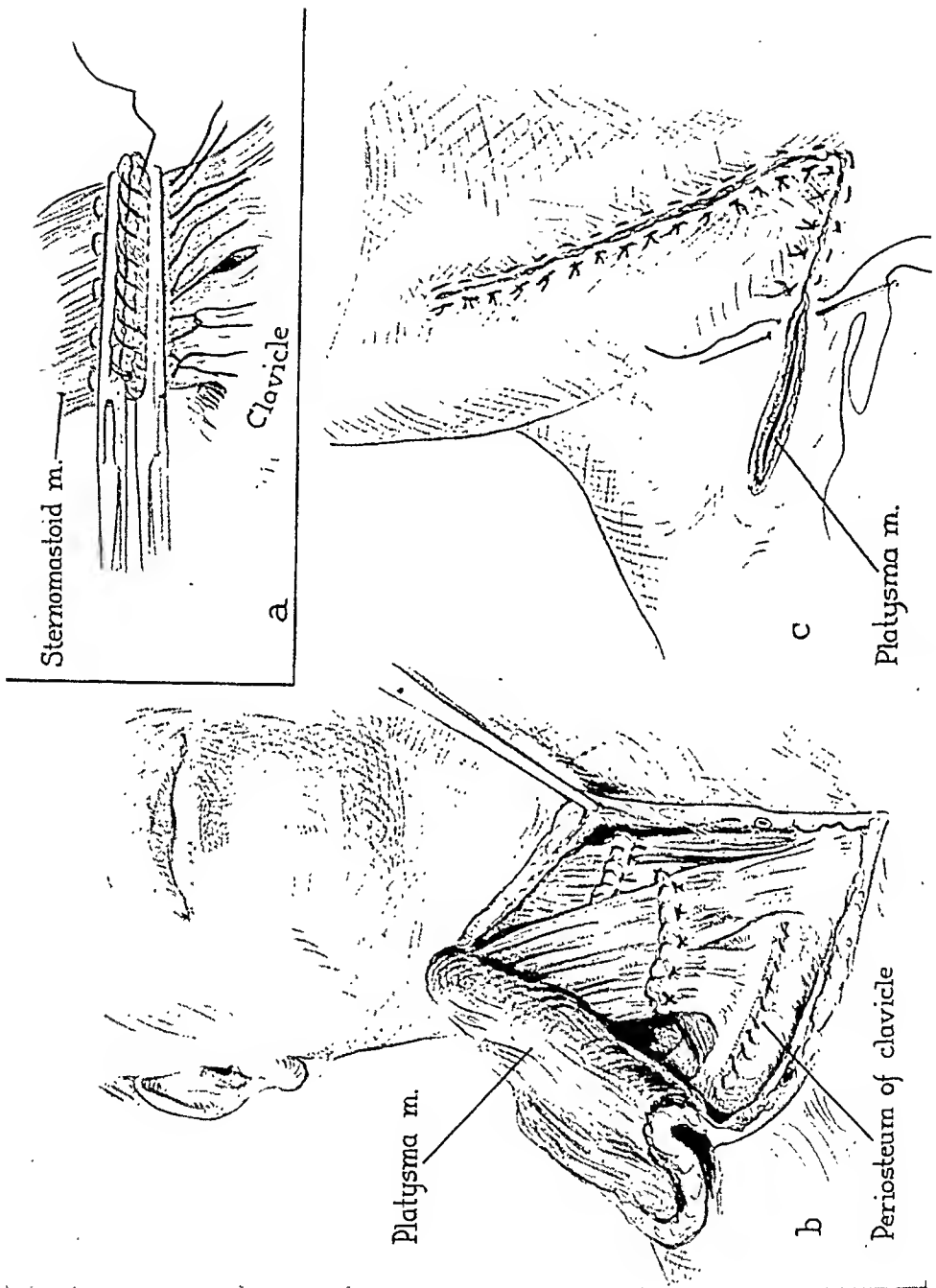


FIG. 7.

on the left. No difference in the contour of the two shoulders. The arms present no apparent differences. Patient is able to raise his arm this afternoon not as high as he did on a previous occasion, not higher than the horizontal (I have seen him raise his arm, putting it on his head). Very little difference in appearance of the two hands as to color and size. The right hand is not as dark as the left. The skin of the right forearm and arm feels about the same temperature as that of the left.

There is no pulsation in the brachial or radial arteries. Pulsation in the common carotid on the right as marked as on the left.

No retrosternal dullness. No difference in percussion resonance on the right side of the chest below the clavicle when compared to the left side. There is no thrill imparted to the examining hand in the right supraclavicular space or below the clavicle.

Heart sounds at the second interspace, on the right, clear, not accentuated, no murmurs. No bruit heard in the supraclavicular region or any point over the chest, either in front or back.

Patient has no difficulty in making a fist, grip excellent. No loss of sensation of pain, heat or cold. No loss of his ability to localize any of these senses.

Pavaex treatment instituted for the purpose of improving the circulation in the extremity, if possible, more rapidly than without it. This treatment would have been instituted sooner but for the transportation difficulties.

November 1, 1935: Since April 18 when the last note was made the patient's general physical condition has progressively gotten worse due to the progress of his pulmonary disease and to his unwillingness to remain hospitalized. So far as the aneurysm is concerned, that is apparently cured. There is no thrill, no bruit and there has been no return of the brachial or radial pulses. The color of the right arm and hand is almost as good as that of the other side. The grip in the right hand is almost as good as that in the left. Because of the pulmonary condition the outlook for life is extremely bad.

SUMMARY.—In the case under consideration there were several interesting and rather anomalous conditions noted.

(1) The patient was no conscious of the existence of the aneurysm for nearly 18 months after the original injury.

(2) The Branham bradycardic phenomenon was not found on several occasions.

(3) The heart was only slightly enlarged, but the existing enlargement diminished following operation.

(4) Postoperatively the radial and brachial pulses have failed to return up to the present time. In spite of this fact, the collateral circulation has been adequate to prevent evidence of atrophy or circulatory disturbance.

(5) The value of Pavaex treatment as an adjunct in developing collateral circulation is demonstrated by the result.

(6) It was my original intention to apply a provisional ligature on the subclavian or innominate artery and the third portion of the subclavian and then to divide the fistula, and do an arteriorrhaphy or an obliterative type of operation. Circumstances prevented the adoption of this procedure.

(7) The operation consisted of ligation of the internal jugular vein, ligation of the right subclavian artery and the innominate vein on either side of the fistula and obliterative suture of the vein and artery at the site of the fistula. Cure of the aneurysm resulted.

(8) So far as I have been able to find, the arteriovenous fistula between

the right subclavian artery and the innominate vein such as existed in this case is unique.

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CLOSED REDUCTION OF RECENT DISLOCATIONS OF THE SEMILUNAR (LUNATE) BONE

WITH RESULTS AND DISCUSSION REGARDING NECROSIS (MALACIA)

REPORT OF ELEVEN CASES

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MANY theories have been advanced as to the cause of malacia of the semilunar bone (Kienbock's disease). Some of these suggest the etiologic factor as fracture, repeated slight trauma (occupational), muscle pull, different lengths of the radius and ulna, the location of the semilunar bone in the wrist, and foci of infection. No theory as presented is in proportion to the amount of trauma usually received by the semilunar bone and its surrounding tissues when dislocated.

Little reference has been made to the development of Kienbock's disease following a closed reduction of a recent dislocation of the semilunar bone. The only statement relating to this is that by Schnek¹: "Malacia of the semilunar bone has never been observed following an early closed reduction of that bone."

The dorsal and palmar ligamentous attachments to the semilunar bone, through which the bone receives its blood supply, must surely be severely traumatized and in many instances partly or completely torn loose from such attachments when dislocation of the semilunar takes place.

Mouat, Wilkie and Harding² state that the main blood supply of the semilunar bone is derived from the dorsal ligaments and would be interfered with in temporary subluxations or other trauma to the wrist, while Schnek states that the volar ligaments containing the nutritive vessels to the semilunar bone always remain intact when it is dislocated. He further states that, even though the dislocated semilunar bone may be felt directly beneath the skin on the flexor surface of the wrist, it always remains within the sac of the tendon sheaths.

It is not the author's purpose at present to prove or disprove the theories advanced as to the causes of Kienbock's disease. It has been his experience that the trauma received when the semilunar bone is dislocated does not produce malacia of the bone, following an early closed reduction by gentle manipulative procedures. This is substantiated particularly by Case 9a and 9b, Tables I and II, in which instance the patient removed the fixation from the hand, wrist and forearm four days after the first closed reduction and played football, redislocating the semilunar. It was again reduced by the closed method. When seen, five years and three months following the last reduction (Table II, Case 9 and Figs. 9b and c), no malacia had occurred.

TABLE I

Case No.	Name	Age	Date Injured	Diagnosis	Complications	Number Days After Injury Before Reduction	Re-turned to Light Duty	Re-turned to Full Duty	Method of Closed Reduction
1	L. M.	27	8-14-24	Dislocated semilunar (lunate) right	None	9	4 wks.	5 wks.	Davis broom-stick
2	L. H.	24	9-17-24	Dislocated semilunar (lunate) right	Fracture scaphoid and styloid process ulna, right	3	8 wks.	10 wks.	Davis broom-stick
3	W. J.	50	3-26-25	Dislocated semilunar (lunate) right	Fracture styloid process ulna, right	3	5 wks.	7 wks.	Davis broom-stick
4	E. D.	53	12-31-25	Dislocated semilunar (lunate) right	Fracture os magnum and scaphoid, right	2	4 wks.	10 wks.	Thumb pressure
5	G. G.	28	6-14-26	Dislocated semilunar (lunate) left	Fracture scaphoid, left	4	5 wks.	10 wks.	Davis broom-stick
6	W. C.	54	8-18-26	Dislocated semilunar (lunate) left	None	2	4 wks.	5 wks.	Thumb pressure
7	P. M.	37	6-27-27	Dislocated semilunar (lunate) left	Fracture left scaphoid and os magnum	3	8 wks.	12 wks.	Thumb pressure
8	S. M.	46	9-12-29	Dislocated semilunar (lunate) left	None in wrist, multiple contusions of body	1	2 wks.	10 wks.	Thumb pressure
9 (a)	H. P.	17	10-2-29	Dislocated semilunar (lunate) left	None	4			Thumb pressure
9 (b)	H. P.	17	10-10-29	Redislocated semilunar (lunate) left (patient removed case ²)	None	2		5 wks.	Thumb pressure
10	D. C.	18	7-24-31	Dislocated semilunar (lunate) left	Fracture lower end of radius	5		6 wks.	Thumb pressure
11*	T. D.	25	7-30-34	Dislocated semilunar (lunate) left	Fracture lower end of radius	4		6 wks.	Thumb pressure

* Patient referred by courtesy Dr. J. M. Mason, Birmingham, Ala.

TABLE II

Case No.	Name	Number of Attempts at Closed Reduction	Occupation	Period of Observation Following Injury	Neerosis (Malacia)	Functional Results
1	L. M.	4	Laborer	5 yrs., 6 mos.	None	Good
2	L. H.	3	Laborer	6 yrs., 5 mos.	None	Fair
3	W. J.	2	Laborer	6 yrs., 11 mos.	None	Good
4	E. D.	2	Laborer	7 yrs., 3 mos.	None	Fair
5	G. G.	1	Laborer	7 yrs., 8 mos.	None	Good
6	W. C.	1	Laborer	8 yrs.	None	Good
7	P. M.	1	Laborer	5 yrs.	None	Fair
8	S. M.	1	Laborer	4 yrs., 6 mos.	None	Good
9 (a)	H. P.	1	Student			
9 (b)	H. P.	1	Student	5 yrs., 3 mos.	None	Good
10	D. C.	1	Student	4 yrs.	None	Good
11	T. D.	1	Laborer	15 mos.	None	Good

In the author's opinion a more basic cause produces malacia of the semilunar bone than is explicable by the theories which have been presented by various observers. Take, for example, two people of the same age and



FIG. 1—Showing the amount of swelling usually encountered in the average uncomplicated semilunar dislocation. Note there is swelling about the whole wrist joint, none of which is extremely marked, which frequently accounts for the diagnosis of a sprained wrist.

race, apparently in the same physical condition, doing the same work, theoretically using the same force and energy with their hands—one develops malacia of the semilunar bone and the other not.

The most logical reason for the basic cause of malacia of the semilunar bone is ably presented in a résumé of investigations made by Murk-Jansen,³ namely: "The compression of the semilunar should be distinguished from the fracture. The fracture is rare. It is only produced after a severe traumatism and is usually accompanied with a fracture of the other neighboring bones. On the contrary, the compression of the semilunar appears insidiously with individuals who make their living with heavy work. With-

out being preceded by any violence whatsoever, the stiffness and swelling of the wrist do not seem to be immediately accompanied by pain but improve with rest.

"It is true that very often either one or the other accuses traumatism, but a close examination shows that this traumatism has only been a strained movement which it is necessary to consider more readily as the revealer of the affection than as the casual agent. The long duration of the latter and the often serious disorder with the mobility of the wrist are both entirely in contradiction with the insignificance of the traumatism.

"Compression of the semilunar is regularly accompanied with compres-

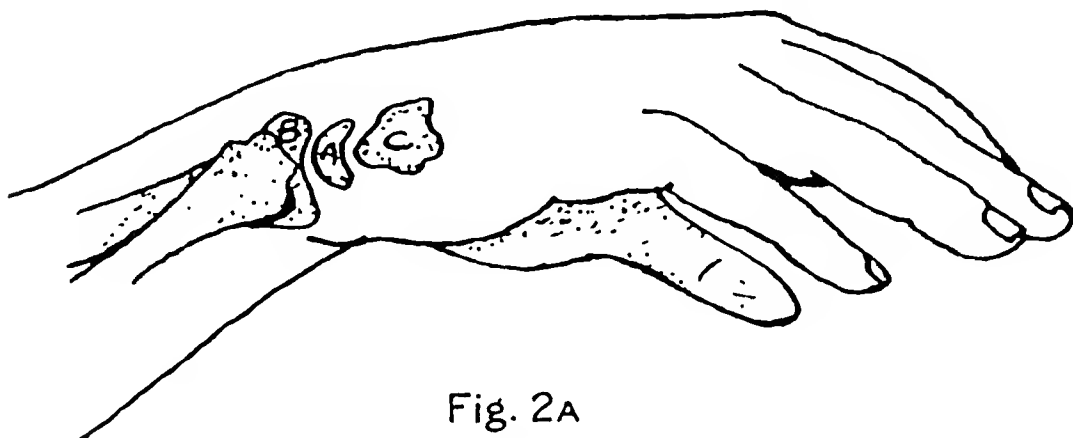


Fig. 2A

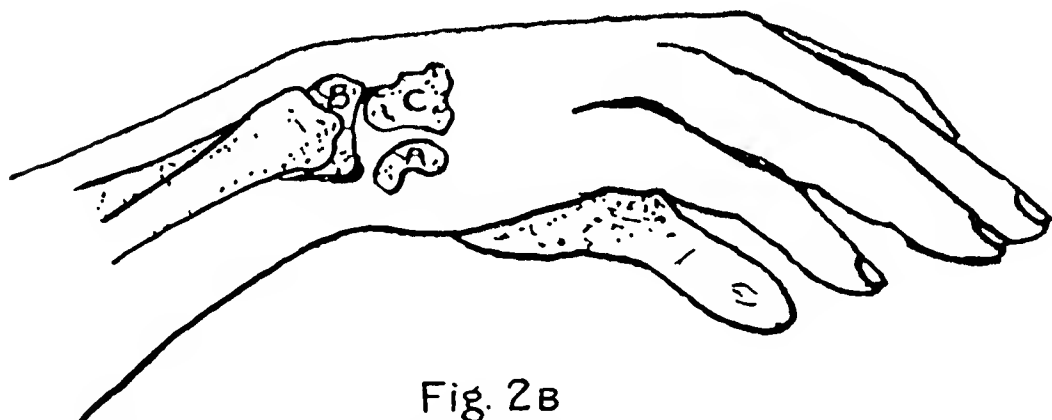


Fig. 2B

FIG. 2 (A).—Sketch showing the relative anatomic relations of the semilunar to the os magnum and the lower end of the radius.

FIG. 2 (B).—Sketch showing a complete dislocation of the semilunar bone. (George G. Davis, Surg., Gynec., and Obst., vol. 37, p. 225, 1913.)

sion of the other bones of the hand. The semilunar is generally more affected, so that one often only notices the compression of this bone.

"Radiographically, the early stages are characterized by the presence of spots of decalcification. It is in the more advanced states that apparently the areas of more marked density show themselves often in the form of thickened lines."

Murk-Jansen further states that he finds the different theories presented as the causes for malacia of the semilunar bone to be inadequate or inadmissible, and proposes the following theory: "The calcium salts which give the skeleton its characteristic rigidity behave on the occasion of variations of functional pressure differently from the colloidal substance in which

they are included. If one inscribes in abscissi the pressure and inordinates the quantity of the salts and of the colloids, one observes that the curve of the salts is raised more rapidly than that of the colloids. One knows that a decrease in pressure entails not only a thinning out of the elements of the skeleton, but also a greater fragility and a more considerable transparency to the roentgen ray resulting from decalcification.

"Chemical researches undertaken by the author have established that the augmentation of functional pressure brings on, besides the thickening of the bony elements, an augmentation of their contents in calcium salts which can be raised to more than 10 per cent of the weight. The ascension of the curve of calcium concentration surpasses, then, in case of increase

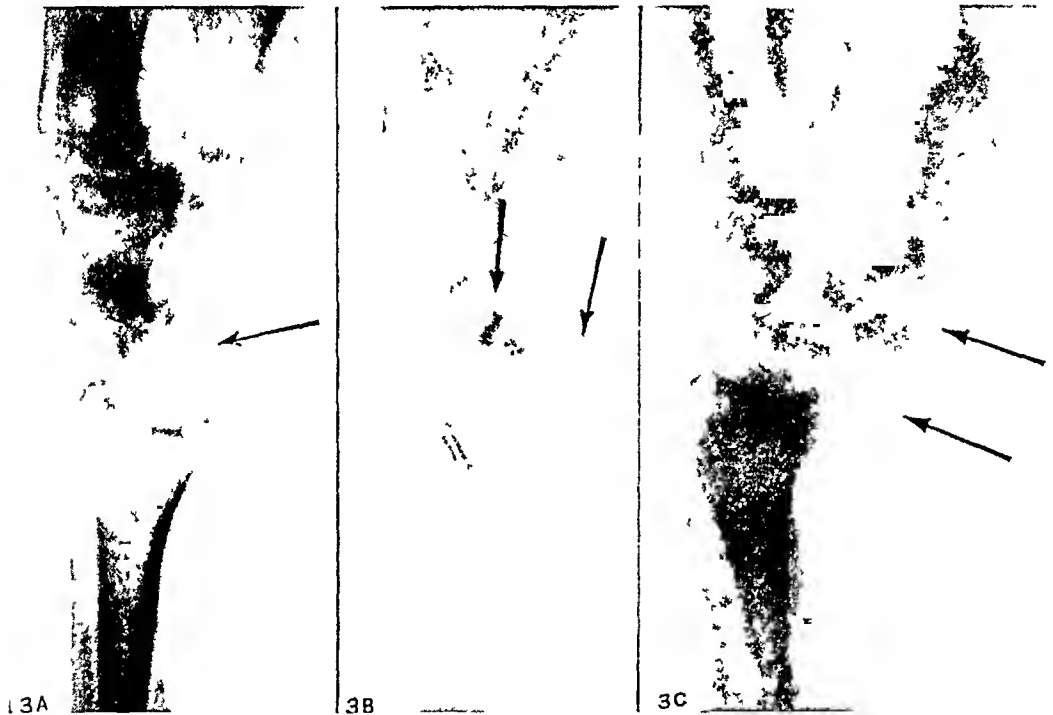


FIG 3—Roentgenograms showing the three stages of the semilunar dislocations (A)—First stage (B)—Second stage. (C)—Third stage

of pressure, that of the curve of colloidal substances. The two lines are cut, and according to the rules of physiology that should also be the case for the descending parts of the two curves. That means that under the influence of a continuous increase of functional pressure it is necessary to expect a more rapid resorption of the salts than of the colloidal substance.

"The author names this state 'excessive plasticity.' The compression or malacia of the semilunar is the expression of this plasticity. Its localization, after a long and hard work, on the level of this bone, results from the fact that it is as well to the dorsal face as to the palmar face of the wrist, the center of convergence of the forces of the extending and bending tendons of the fingers. At a certain degree of excessive plasticity, the prolongation of intensive work determines the plasticity by fracture."

Following this conclusion, Murk-Jansen states that surgeons have oc-

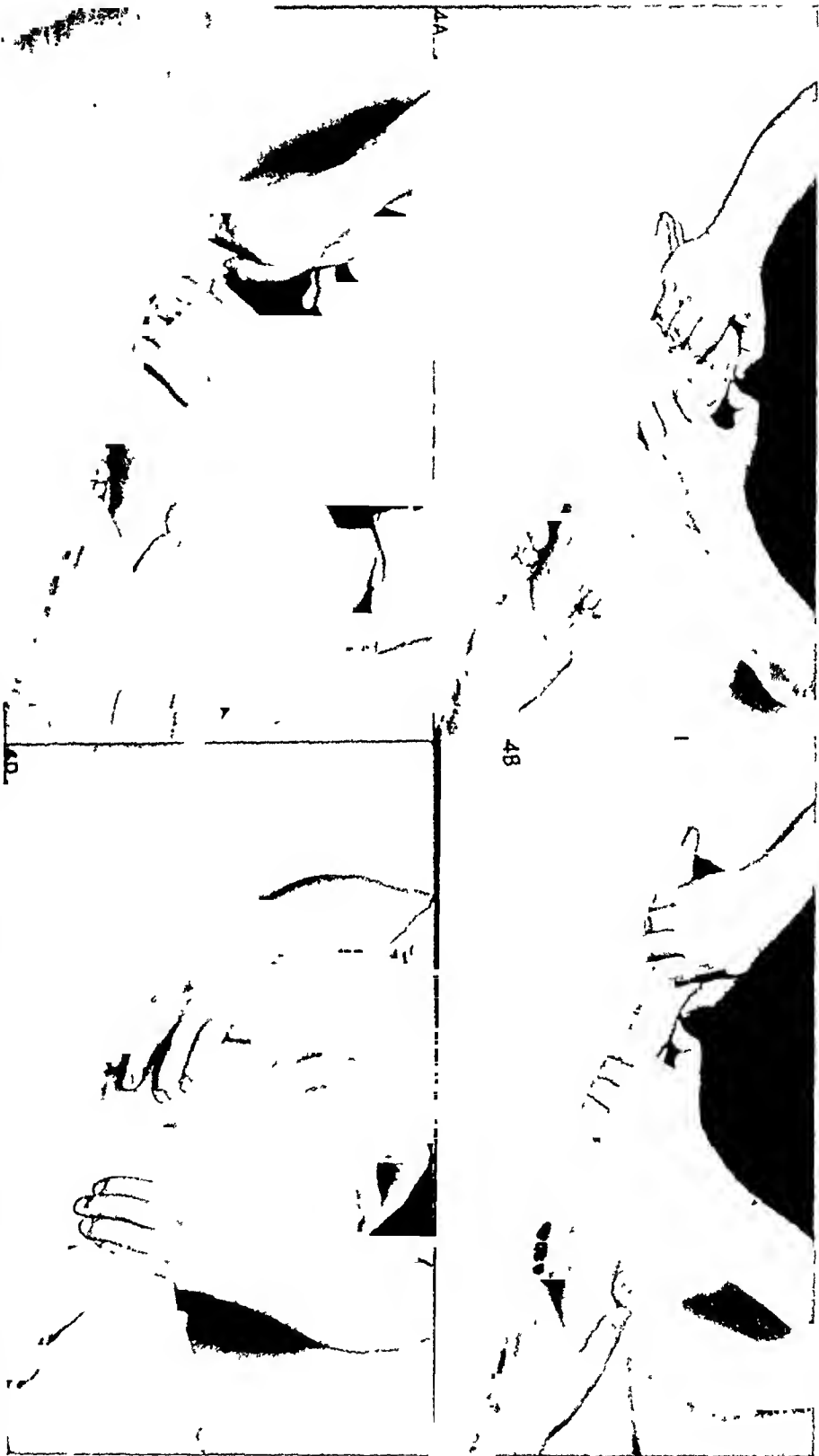


Fig. 4.—Showing manipulative methods carried out when using the thumb method technique in reducing the semilunar bone by the closed method. (A)—The hand is hyperextended at the wrist and while strong traction and countertraction are being made to the hand and forearm, an even, firm pressure is being made by the thumbs directly over the dislocated semilunar. This pressure of the thumbs is continued throughout the whole manipulative procedure. (B)—The traction and countertraction and pressure over the semilunar is continued while the hand at the wrist is going through the process of being flexed. (C)—With traction and countertraction and thumb pressure over the dislocated semilunar being carried out as previously described, the hand is suddenly and firmly flexed at the wrist joint at which time the semilunar is usually felt to slip back in place. (D)—Shows the position of the hand which is usually assumed after a complete reduction of the dislocated semilunar is accomplished. If there is a tendency for the hand to voluntarily extend at the wrist after the manipulative procedure, it is usually true that the semilunar bone has not been reduced. Exceptions to this sign are usually found in cases where the wrist is markedly swollen or in that type of case where the diagnosis has not been made until several days following the dislocation, when there is marked rigidity and tenderness about the wrist.



FIG. 5—Showing the postoperative fixation which should be applied in most cases, except in the severely injured wrist where there is tremendous amount of soft structure involvement, in which case wooden splints, well padded, are more applicable. The hand should always be flexed at the wrist joint about 40° to 45° for at least four or five days. Note that the sugar tong plaster splint, by extending around the elbow, prevents rotation of the forearm (B). It is very necessary that rotation of the forearm be prevented. Either a very light, moderately snug fitting circular plaster bandage can be applied around the sugar tong splint (C) or a plain, cotton bandage.

cupied themselves too much with the hypotheses of embolism, infusion, traumatism, *etc.*, and have failed to recognize the first phase as described above, when it is the very one which prepares the entrance for the second phase.

According to Murphy⁴ there are three stages or degrees of dislocations of the semilunar bone. "The first stage is the production of the dorsal dislocation of the hand on the wrist with the semilunar bone remaining *in loco*, that is, fastened to the radius and ulna by the anterior ligament and less frequently by the posterior also.

"The second stage of the deformity is brought about only when the posterior radio-ulnar ligament has been ruptured, either by the original injury or by efforts at reduction of the luxation. The anterior pole of the semilunar then remaining fixed, the posterior pole radiates forward about the anterior pole as an axis, the degree of rotation depending on the mechanical factors present tending to pull the hand forward and upward.

"So marked may this rotation become that the semilunar may turn through an arc of more than 180° and come to lie well up on the anterior surface of the wrist and of the forearm, in the so called third stage of the affection."

In the author's experience the majority of the dislocations of the semilunar bone come under the first and second stages. In this series the first stage of dislocation cases has not been included. Such involvement has not been considered by the author as a true semilunar dislocation. In the 11 cases reported seven were in the second stage and four in the third stage.

McBride⁵ has said that the dislocation of the semilunar bone is the third most frequent injury in the wrist joint, Colles' fractures and fractures of the scaphoid being more frequent; and further states that this does not, however, make such an injury as dislocation of the semilunar bone third in importance as to involvement and disability of the wrist joint. Grave results may occur from failure to diagnose such a condition and from neglect to apply proper treatment early.

Cohn⁶ appropriately outlined the importance of early and proper diagnosis of an injury about the wrist joint, as follows: "One of the most frequent types of case which we are called upon to treat is injury of the wrist. Fractures of the base of the radius form by far the greatest number of these cases, but in making the examination it is necessary to bear in mind the many other conditions which might result from the violence. Each in turn must be eliminated. Each type requires its special treatment.

"The possible injury to the wrist can be eliminated only by a systematic examination which takes into account the anatomic landmark as well as the probable reason for each symptom and sign which is evident. The casual examination upon which a diagnosis or opinion is made cannot be justified in the light of properly interpreted roentgenograms or by the disabling results which follow in their wake."

Anteroposterior and lateral roentgenographic views should be made of

every suspicious wrist injury when possible. While the lateral views are very important in showing a dislocated semilunar, the anteroposterior view is just as necessary because it shows fractures and other complications about the wrist when the semilunar is dislocated. The importance of such roentgeno-



FIG 6—Showing type of fixation after the hand has been extended at the wrist joint to mid flexion and extension. This should be carried out usually on the fifth or sixth day. Flexion of the hand at the wrist over too long a period is not desirable, because there is a tendency for the flexor tendons to become spastic. The above fixation remains on about ten days, after which time the arm is carried in a sling for two or three weeks, the patient using hot baths, and gradually increasing active motion.

graphic observations is shown in these 11 cases of which seven cases had fractures of the other bones which make up the wrist joint (Tables I and II).

It is needless to say that, if these diagnostic warnings and precautions are adhered to, and if early closed reduction of the dislocated semilunar bone is carried out under gentle manipulative procedures, the convalescence

and disability will be greatly lessened. In many cases no disability will result, especially in uncomplicated cases.

Davis⁷ describes the force which produces the semilunar dislocation as follows: "In analyzing the force producing this dislocation, it is constantly found that the hand is pushed in a dorsal flexion position, that is, the force is directed from the palmar to the dorsal hand direction. A second force is exerted by the muscles and ligaments going from the forearm to the hand, pulling the hand toward the arm. The position of the hand at the time the dislocation is produced is that of extreme extension."

Considerable difficulty in reducing a semilunar dislocation is usually encountered after the fourth or fifth day following the accident. It has been the author's experience that, after seven or eight days in the case of

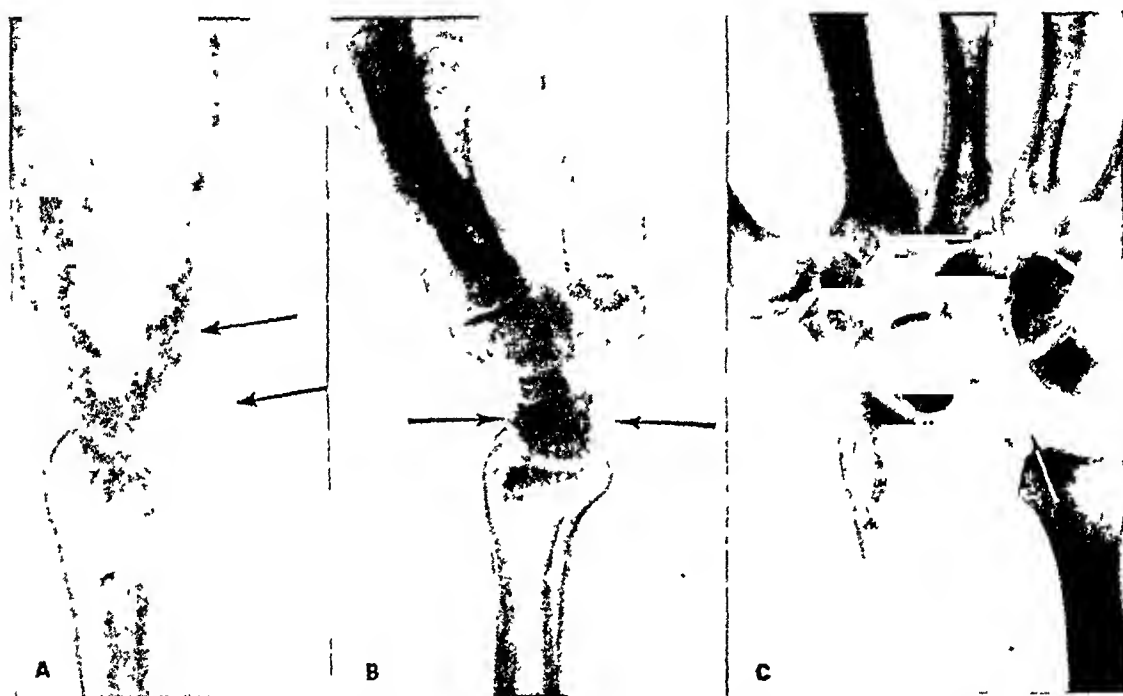


FIG. 7. (Case 1.) (A)—Roentgenogram showing the dislocated semilunar bone. (B) and (C)—Roentgenograms five years and six months following a closed reduction. No malacia present.

the unreduced dislocated semilunar, the amount of trauma used in attempting to reduce, or in reducing the semilunar frequently, in the most capable hands, usually produces such damage that more disability results from such procedures than by removal of the bone. Such opinion, however, is not shared by certain authorities⁵ who report excellent results by open operative replacement of the dislocated semilunar bone.

Usually in experienced hands when these cases are seen early, it is seldom necessary to make more than one or two attempts at closed manipulative reduction by thumb pressure before reduction is accomplished. It will be noted in Table II that the author had little difficulty, after the first two cases, in reducing the dislocated semilunar by the closed reduction method. After conservative attempts by gentle, manipulative procedures have failed to reduce the bone by the closed method, it should be removed.

In the reported cases, those which did not develop full function had a



Fig. 8. (Case 5.) (A)—Lateral roentgenogram showing the scaphoid bone dislocated. An anteroposterior view of this case showed a fracture of the scaphoid. (B) and (C)—Roentgenograms seven years and eight months following closed reduction. Note the union of the scaphoid and no malacia of the semilunar. (D) and (E)—Functional results.

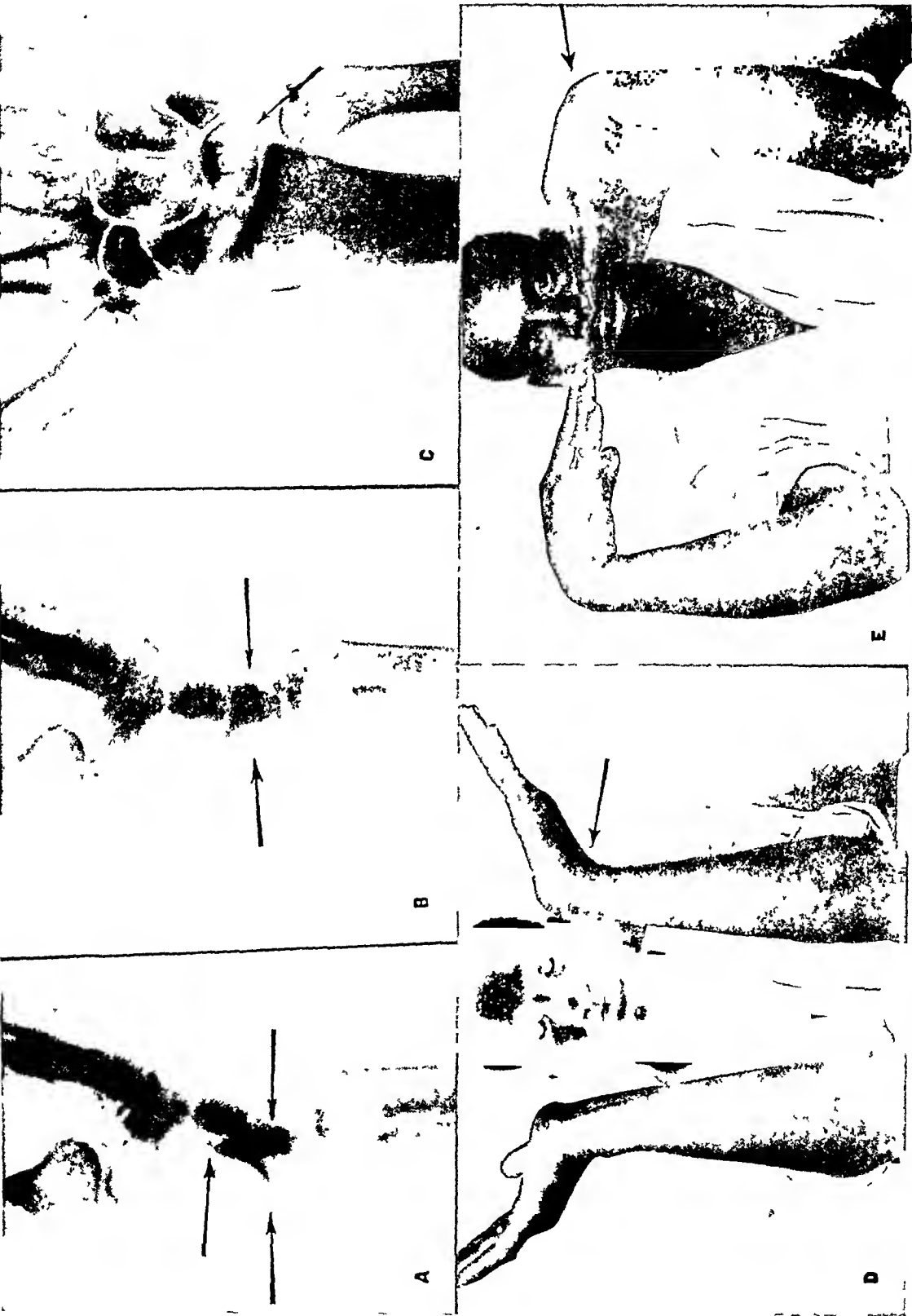


FIG. 9. (Case 9B.) (A) —Roentgenogram following second dislocation of the semilunar. (B) and (C) —Roentgenograms five years and three months following second closed reduction of the semilunar bone. No malacia present. (D) and (E) —Functional results.

fracture or fractures of other wrist bones, and the disabilities were the result of these. No uncomplicated dislocated semilunar had any disability.

Steady, firm, localized pressure directly over the palmar surface of the wrist and the dislocated semilunar bone is necessary in reducing it. This pressure should be made by the operator's thumbs only. The author has in the last few years reduced all cases by this method and has, thereby, lessened trauma, disability and the period of convalescence. As noted in Table I the Davis broomstick method was used in four cases without first trying the thumb pressure technic. In these four cases there is no doubt but that the broomstick pressure did prolong the disability, but no permanent disability resulted. The technic of the thumb pressure method is described and shown in Figs. 4 a, b, c and d.

Following the reduction in the uncomplicated cases, fixation should be used for 12 or 14 days. The technic for fixation is shown in Figs. 5 a, b, c and 6 a and b. In the complicated cases the fixation varies with the type and severity of the complications.

This series of 11 cases of dislocated semilunars with 12 dislocations and closed reductions occurred over a period of ten years. The average period of observation of each case was five years and six months. The average age was 34 years and five months. All cases were anteriorly dislocated. The posterior or dorsal dislocation is very rare (Robinson⁸).

There was a slight transitory median nerve anesthesia in cases four and seven, which was present immediately following the injury but cleared up without complications within a short time following reduction. A general anesthetic was used in every case. Local anesthesia is contra-indicated in such cases on account of increasing local deformity and edema. Intravenous anesthesia today is probably best.

CONCLUSIONS

(1) Necrosis (malacia) of the semilunar (lunate) bone does not take place following an early closed reduction of the bone, provided proper, careful, gentle manipulative procedures are carried out.

(2) Careful physical and roentgenologic examinations should be made of every suspicious, injured wrist joint.

(3) When early diagnosis is made and proper and early closed reduction is carried out, the uncomplicated semilunar dislocation should obtain good functional results.

(4) The thumb pressure method is simple and less traumatizing.

(5) The closed reduction method should be attempted first, provided not too much time has elapsed following the dislocation.

(6) Fixation of the hand, wrist and forearm for 12 to 14 days in the uncomplicated case is necessary following reduction, a longer period in the complicated case is desirable.

(7) Great care should be exercised in carrying out too severe and pro-

longed attempts at closed reduction. If the semilunar cannot be reduced by the closed method it should be removed.

(8) The majority of dislocations are complicated by fractures about the wrist joint.

(9) General anesthesia is usually necessary. Intravenous anesthesia is indicated today.

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DISCUSSION OF THE PAPERS OF DOCTORS CONWELL, BENNETT AND HENDON

DR. OSCAR L. MILLER (Charlotte, N. C.).—In this paper Doctor Bennett has brought out the two important principles in treatment necessary to obtain union in fractures of the humerus. The principles apply to either recent fractures, delayed or nonunion, and are proper bone contact and immobilization. If an acute fracture of the humerus, treated by so called conservative methods, shows no evidence of union at the end of eight weeks, I consider open surgery indicated just as much as if it were a case of orthodox nonunion. Ordinarily, you know, we do not consider nonunion existent until some six months or a year after failure of a fracture to unite.

Unless one uses a strong well applied Lane plate there is always hazard in getting a safe fixation dressing on the arm after operation. Some heavy inlay bone grafts might be secure enough to allow one to move the arm about while applying a dressing after operation but it is good practice to apply a shoulder spica the day before operation and fenestrate it over the humeral region. With this preliminary part of the dressing in place you may expect to easily secure the fractured humerus after operation—control it perfectly during convalescence, and have an ambulatory splint which can be worn until the function of the arm is well recovered.

Important as the operation is as carried out on the fractured humerus, much importance must also be attached to recovering the functions of the humeral and shoulder muscles. Using the spica and maintaining the arm in abduction until some muscle tone has been developed, after union of the fracture is accomplished, constitutes a highly important part of the treatment in most cases.

DR. WILLARD H. PARSONS (Vicksburg, Miss.).—I wish to very briefly discuss my experience with fracture of the neck of the femur, and will limit

my remarks to Doctor Hendon's paper. I propose to contrast in a small number of cases, treated with what Doctor Hendon chooses to call the bone Key, with a series of cases treated with the usual plaster encasement (Whitman's technic).

During the past few years we have operated upon seven cases using Doctor Hendon's method, the youngest 64 years of age, the oldest 84. There was one death in this series, and this I think might easily have occurred in the same space of time had the patient received no treatment at all. She was known to have advanced carcinoma, was in a poor state of nutrition, and six months before the fracture she sustained a cerebral injury following which she fell from her bed and fractured the neck of the femur. The Key was inserted and there was no postoperative difficulty. She died four days later.

The remaining six patients all obtained excellent results. No difficulty was experienced at operation. The operation, as Doctor Hendon has written on many occasions and now repeats, is very simple. None of the patients showed more than the average postoperative shock. All were private patients. They were allowed out of bed at the end of 12 days, and union was obtained in all. They were permitted to walk with a crutch within six weeks and to begin weight-bearing at the end of 12 weeks. A typical case was that of a white male, aged 64, who fell from a ladder and fractured the neck of his femur. He was brought by ambulance to the Clinic and on the following day I reduced the fracture and inserted a bone Key. On the twelfth day he was allowed out of bed and on the sixteenth postoperative day he returned to his home in Memphis, Tenn., a distance of more than 200 miles from Vicksburg. He reported six weeks later getting about quite well on crutches, and 16 weeks from the date of his injury he traveled to Flint, Mich., purchased an automobile and drove it home.

I reviewed for comparison the records of seven patients treated by what might be termed the orthodox fashion. These patients remained in the hospital an average of 54 days. It is difficult to care for a patient at home, or for that matter elsewhere, encased in a large, bulky plaster spica. These patients were younger than those in the first series—none was over 60. Of the seven patients one died. Satisfactory union or good results were obtained in five patients and in one there was nonunion.

DR. ROBERT CAROTIERS (Cincinnati, Ohio).—Doctor Conwell has been fortunate in seeing so many cases, more than the average man sees in a lifetime. I think his method of reduction and his results are good, and I would like to know whether he ever uses extension of the second finger with a wire in the tip of the finger and then attached to the machine arrangement to help retain the reduction. I have not done this myself, but would like to know if he has. His description of the blood supply is very interesting and explains many things in connection with the wrist joint. This joint is peculiarly free from tuberculosis, and I imagine that the blood supply may be one of the things responsible for this.

Doctor Bennett's paper also is very interesting. For the last ten years we have used, in the treatment of simple fracture of the humerus, an airplane splint made out of Cramer wire. We like this because it is easily applied, you have the case before you all the time, and you can care for it easily, and I believe we get a better blood supply, which is very important. It has proved quite satisfactory. We have been able to get some uncomplicated cases out of the splint in four weeks. We have recently had some ununited fractures and have employed the usual methods of treatment. Recently we had to operate a second time because the graft broke. We reoperated after about six months. The complicated cases are the difficult

ones and operation is advisable, I think, when you have this trouble. We have recently seen a most interesting case which I cannot quite explain. A man was seen who had nonunion at the junction of the middle and lower third of the humerus for about one year. He wore a brace which held it in very good position. I examined him a year later, and union had taken place, although nothing was done.

DR. EDWARD T. NEWELL (Chattanooga, Tenn.).—I reported last year at the meeting of the Southeastern Surgical Congress a series of 10,082 fractures. In that series 216 fractures of the humerus were included. Of these, there were eight that required open operation. This number does not include the cases of compound fracture that we cut down upon immediately.

In regard to the method of fixation, as has been said by the essayist and several of the speakers, there are many methods. We prefer to use the Murry-Jones splint when the fracture is in the upper third for the initial treatment, and later we use the airplane splint, especially in the middle and lower third cases. In the elbow fractures, we like to use the Jones method. In children, the modified Jones method, on account of the great swelling that is usually present, is especially applicable.

I find that our statistics agree with Doctor Bennett's in that we have had only one ununited fracture where we have treated the case from the beginning. The treatment as outlined by Doctor Bennett is very effective and gives very satisfactory results.

DR. W. BARNETT OWEN (Louisville, Ky.).—I feel that Dr. Conwell has presented quite a large series of dislocations of the semilunar in which he has been successful in getting reduction by the closed method. That is due to two factors. First, he was fortunate in getting the cases early. Second, his technic was properly executed and he was able to get the reduction before the necrosis in the semilunar had taken place. I have had only three cases of palmar dislocation of the semilunar, and have not seen any dislocated dorsally. I believe we should always examine cases very carefully following injury of the wrist, even though it may appear trivial. It is possible to get dislocations and if allowed to persist for two or three weeks it is almost impossible to reduce them by the closed method. I saw one case a few years ago in which an open operation was performed. Necrosis followed and it was necessary to remove the semilunar bone. I believe in those cases if they have been allowed to remain out for any length of time it is probably better to remove the bone entirely and you will have less disability.

Doctor Bennett's paper, in which he discusses fracture of the humerus, especially referring to nonunion, is of particular interest to me. It is rather significant that of 15 cases of nonunion of the humerus, 14 of them had had primary open reduction and fixation. Only one case had not been operated upon. Principles and not methods should be considered. Reduction and maintenance in the simplest way, not the most complicated, should ever be borne in mind. Doctor Bennett has presented the subject clearly, thoroughly, and practically.

DR. H. EARLE CONWELL (closing).—In answer to Doctor Carothers' question I wish to say that I have not found it necessary in the recent semilunar dislocations to use skeletal traction through the proximal phalanges or through the distal end of the metacarpals.

It is our responsibility to recognize these cases early and make attempts to reduce them promptly. By so doing we can obtain full function in almost every case with a minimum period of convalescence.

FRACTURES OF THE HUMERUS WITH PARTICULAR REFERENCE TO NON-UNION AND ITS TREATMENT

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BALTIMORE, MD.

It is an admitted fact that non-union occurs more frequently in the humerus than in any of the other long bones of the human body, and also that it is the transverse and short oblique fractures of the middle third of the humerus which present the greatest difficulty. Many long and theoretical discussions have been written as to the cause of non-union which I shall not review here, but shall endeavor to demonstrate that fractures of the humerus will unite if good approximation of the fragments is obtained and complete immobilization secured. This is true not only in the treatment of fresh fractures but also in old cases with nonunion.

Immobilization of the humerus is difficult and cannot be accomplished by traction splints. These splints may be successfully used in the treatment of long oblique and spiral fractures and as a means of reducing a transverse fracture. However, sufficient immobilization cannot be obtained by this type of apparatus to assure the healing of a transverse fracture.

The reduction of a fracture of the humerus is simple in most instances and can be accomplished by manipulation or traction, but it is difficult to secure complete immobilization. This is largely due to muscle pull, as emphasized by Magnuson.¹

I can recall only one case of non-union of the humerus in the practice of the late Doctor Baer and myself, and this occurred in an individual whose general condition was such that ideal treatment could not be carried out. Later, operation was performed and a perfect result obtained. I believe the reason for this success has been due to strict adherence to the points mentioned—good bone approximation and rigid immobilization. If, at the end of two weeks, it was found that approximation of fragments could not be obtained by conservative means, then the patient was operated upon and alignment secured, muscle or fascia disengaged, and the fragments held in position by plates, intramedullary dowels, wire, *etc.* In many instances none of these materials was used, as after the removal of the tissues from between the fragments it was found that external splinting was adequate to maintain the bone in position. Many patients were operated upon through a window in a plaster dressing. In our hands the best method of securing immobilization has been by the use of a plaster dressing which encases the entire arm and shoulder, and very often the thoracic cage—a shoulder spica.

The humerus is the only bone in the body in which a longitudinal displacement of fragments can easily occur. The weight of the plaster dressing plus that portion of the arm below the fracture is sufficient to produce this,

(CASE 1)



FIG. 1.—Mrs. G. H., October, 1927, fourteen months following injury. Two previous operations. Injury to musculospiral nerve.



FIG. 2.—Mrs. G. H., two months after operation.

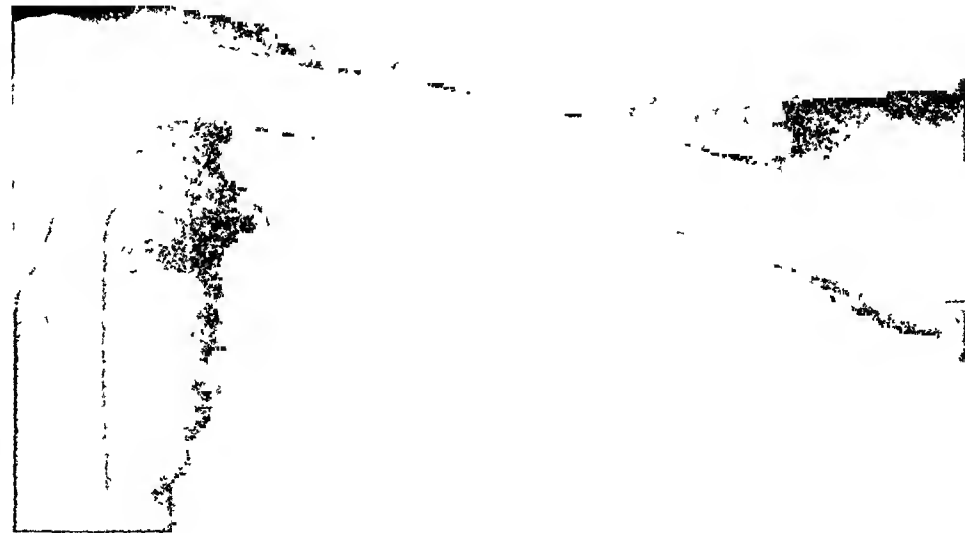


FIG. 3.—Mrs. G. H., one year after operation.

and to cause the soft tissues to become engaged between the fragments unless the shoulder and body are included in the dressing so that the weight

(CASE 2)



FIG. 4.—Mrs. J. B., nonunion of humerus. Three years after original injury.



FIG. 5.—Mrs. J. B., immediately after operation.



FIG. 6.—Mrs. J. B., March 15, 1929. Two months after operation.



FIG. 7.—Mrs. J. B., nine months after operation.

of the dressing is borne on the shoulder and clavicle above the line of fracture.

I do not mean to state that the majority of cases of transverse fractures

(CASE 3)

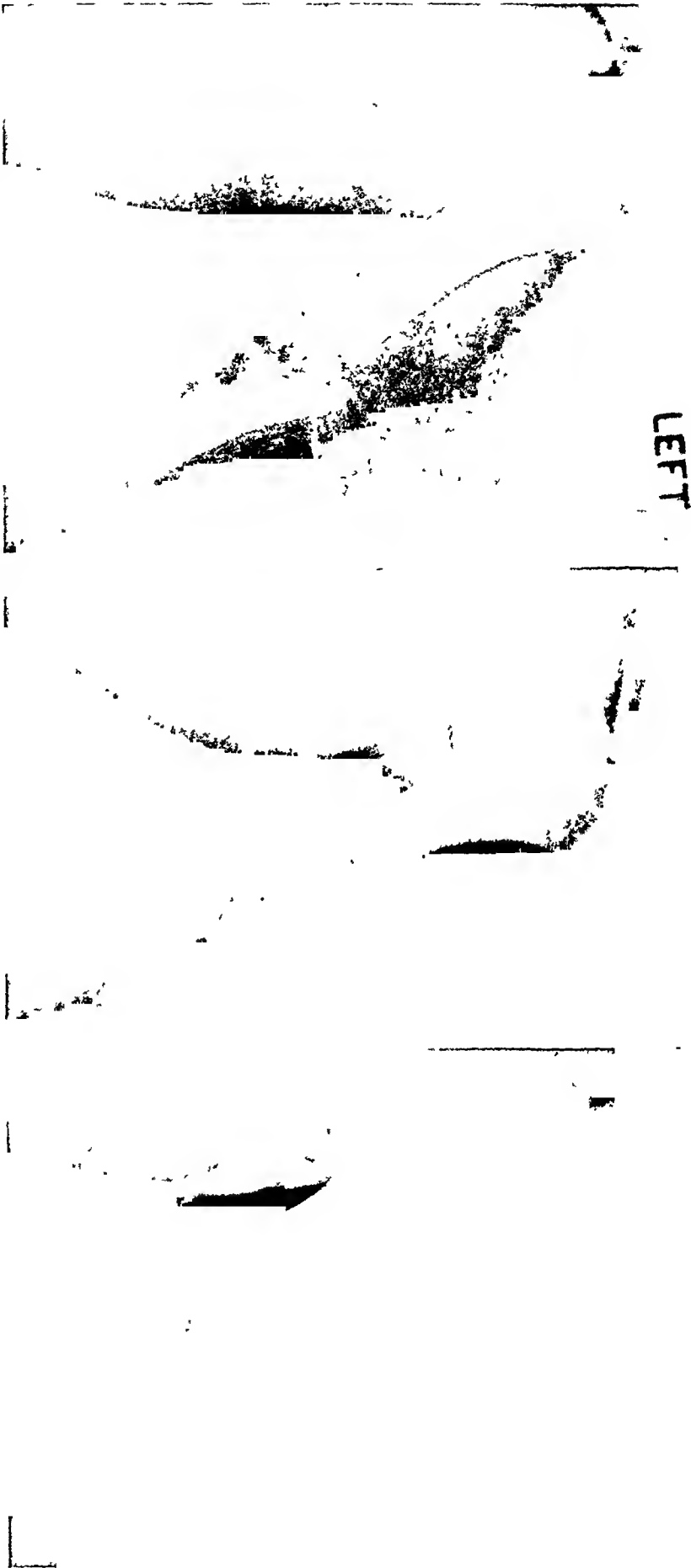


FIG. 8.—Mrs. W. P., October, 1927. Nonunion of humerus. Two months after injury.

FIG. 9.—Mrs. W. P., November, 1929. One year after application of Lane plate.

FIG. 10.—Mrs. W. P., June, 1931. End-result. After removal of plate.

of the middle third of the humerus are to be classified as operative cases, but I do wish to stress the point that it is absolutely necessary to have secure immobilization if one is to expect union to occur in this fracture, one which is slow to unite even under the most favorable conditions.

The treatment of non-union of the humerus presented a very difficult problem for many years. The first step in progress began with the use of the bone graft operations. This was only fairly successful until the technic

(CASE 4)



FIG. 11.—Mrs. M. W., operation eight months after injury. Bone screws completely absorbed five years after operation.

developed by Henderson² was introduced. He advocated the use of a massive bone graft securely fixed to both fragments with bone screws. Campbell³ modified this type of treatment by the use of the onlay graft and substituted an autogenous dowel in place of the beef bone screw for fixation. Both of these surgeons emphasize the fact that a large graft is necessary and should be so securely fixed as to give complete immobilization. Magnuson,⁴ Henderson⁵ and Speed⁶ all feel that firm fixation probably plays as great a part in the healing as the graft itself. I have not used grafts in non-union of the humerus for many years, having long ago been convinced of the fact that accurate bone approximation and secure immobilization would insure the occurrence of union. The technic which we use is the conversion of the fracture into either an oblique or the step type of overlap, fitting the fragments very accurately and holding them in position by

RIGHT 9

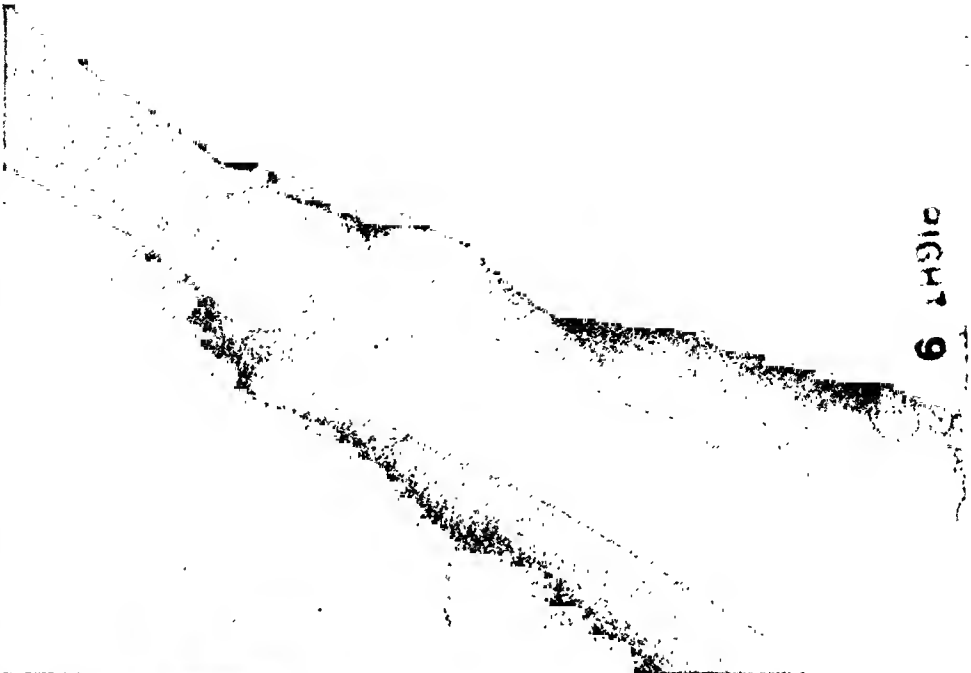


FIG. 12.—J. R., September, 1928. Nonunion of humerus. Operation 18 months after original injury and following two unsuccessful attempts at bone graft.

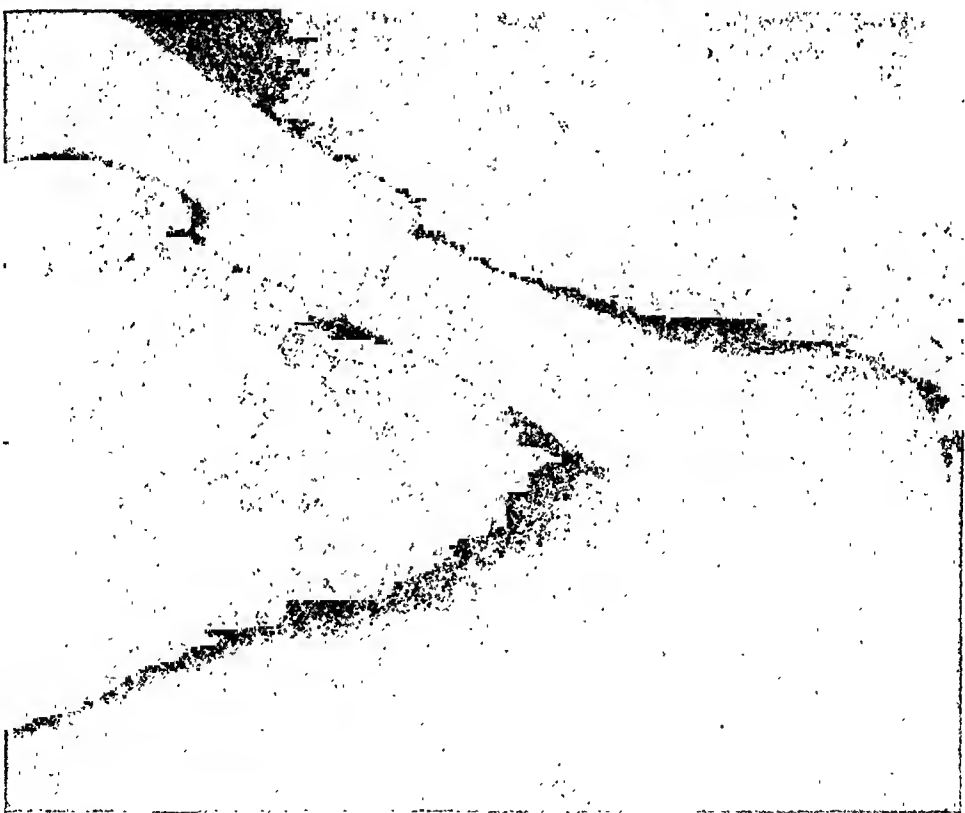


FIG. 13.—J. R., May, 1932. Three years after operation.



FIG. 14.—J. R., June, 1929. After operation.

(Case 6)



FIG. 15.—L. B., February 19, 1929. Non-union of humerus. Five months after injury.



FIG. 16.—L. B., unsuccessful operation. Breaking of bone screw. Injury to musculospiral nerve.



FIG. 17.—L. B., second operation, May, 1930.



FIG. 18.—L. B., four months after second operation.

means of beef bone screws and circumferential wire. Appended are reports of nine cases which have been operated upon by this method, all of which have been successful, and one unsuccessful case.

(Case 7)



FIG. 19.—Mr. J. L., aged 45. Eight months after injury. Extreme atrophy of humerus.



FIG. 20.—Mr. J. L., aged 45. Four months after unsuccessful operation.



FIG. 21.—Mr. J. L., aged 45. Three months following second operation, union of humerus occurring.



FIG. 22.—Mr. J. L., aged 45. Four months after operation, solid union with good functioning arm.

CASE REPORTS

Case 1.—Mrs. G. H., aged 39. Sustained fracture of right humerus and clavicle, August 18, 1926. Satisfactory union of clavicle. Two months later operated on for non-

union of humerus. Fascia and muscle tissue removed from between the fragments. After operation developed wrist drop which required a transplantation of the musculospiral nerve. After operation wore a splint for several months. Non-union persisted. Exam-
(CASE 8)

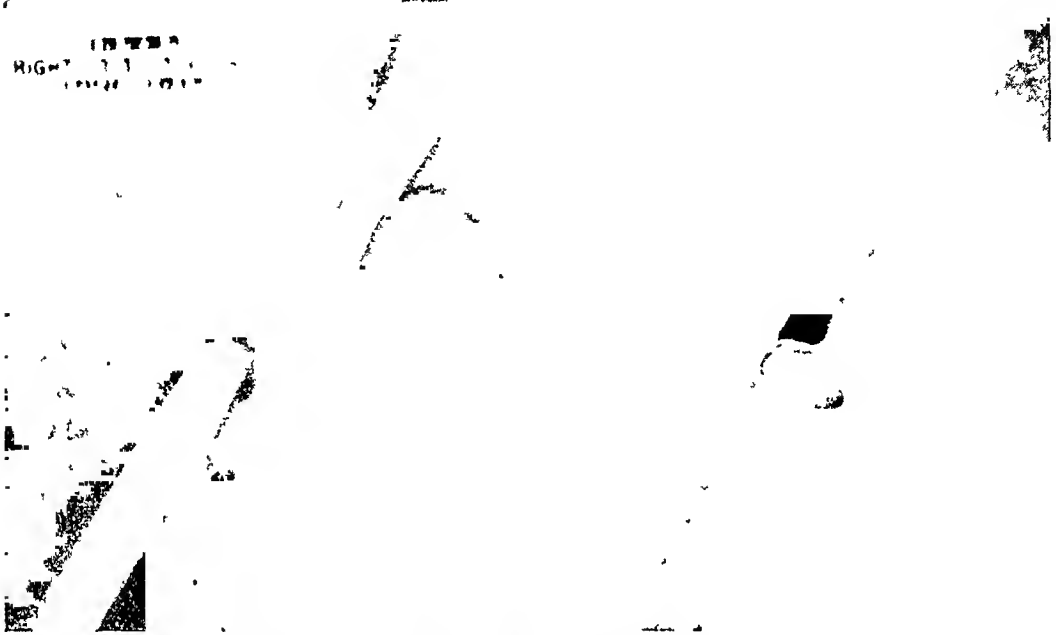


FIG 23—E. H., aged 17. Six months after injury, with extensive damage of soft tissues and musculospiral nerve.

FIG. 24—E. H., March 19, 1931. Unsuccessful operation. Accident in application of plaster dressing.



FIG 25—E. H., July 23, 1931. Four months after second operation.



FIG 26.—E. H., eight weeks after operation.

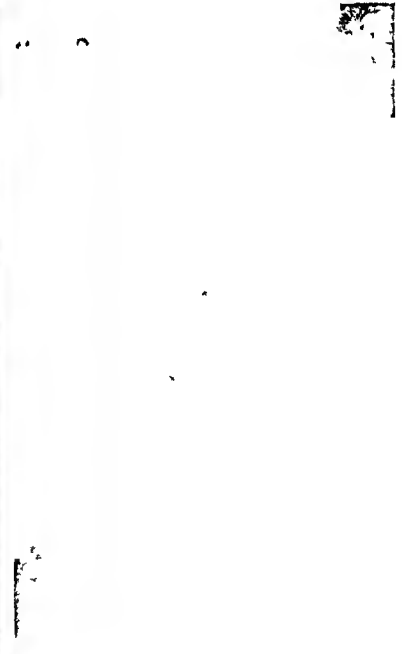


FIG 27.—E. H., seven months after operation.

ined April 16, 1927. Admitted to Union Memorial Hospital, October 3, 1927, approximately 13 months after injury. Fracture line exposed and fragments converted into the oblique type and fixed with bone screws. Patient made an uneventful recovery. Firm union three months after operation.

Case 2.—Mrs. M. J. B., aged 49. Examination January 8, 1929. Fracture of right humerus, middle third, three years prior to examination. Treated by short plaster dressing extending from just below the shoulder to and including the elbow and forearm. At time of examination showed the usual deformity associated with non-union of the humerus at this point. Operation, conversion of the ends of the fragments into oblique type, fixed with bone screws and circumferential wire. Patient made an uneventful recovery with a perfect functional result.

Case 3.—Mrs. W. P. P., aged 47. Examination November 6, 1927. Two months previously had sustained fracture of middle third of left humerus. Treated with short plaster dressing. Result, non-union. Operated upon on two occasions by author. At first operation, two months after original injury, bone screws not available and bone peg used which allowed the fragments to become disengaged. Continued to wear brace for several months. Patient reoperated upon October 11, 1928, and ends of the bone at the point of fracture scarified and Lane plate applied. Satisfactory union obtained. Plate removed several months later.

Case 4.—Mrs. M. W., aged 20. Admitted to Union Memorial Hospital, December 2, 1925. Fracture at the junction of the lower and middle third of the humerus. Treated by house officers with Jones humeral splint and short plaster dressing. Result, non-union. Operation, August 2, 1926, eight months after original fracture. Fragments converted into oblique type and held in position with bone screws and shoulder spica. Result: Splendid function of arm.

Case 5.—Mr. J. L. R., aged 42. Fracture of right humerus, February 13, 1927, nonunion. First operation for bone graft August 14, 1927, six months after original fracture. Result unsatisfactory. Second operation by Dr. W. S. Baer, June 8, 1928, bone graft—17 months after original fracture and ten months after unsuccessful bone graft. Attempt at inlay graft was also unsuccessful and non-union resulted. April 27, 1929, operated upon by Doctor Baer and author—step type of coaptation obtained with considerable shortening of the arm. Bone screws and silver wire used. Result—very marked shortening of the arm but good function.

Case 6.—Mr. L. B., aged 21. Fracture of middle third of right humerus. Patient admitted to Union Memorial Hospital September 1, 1928. Treated with Jones humeral splint for several months. Result, non-union. Operation five months after original fracture—conversion of transverse into oblique fracture. Held in position with bone screws and silver wire. Author assisted the resident surgeon, leaving the closing of wound and application of dressing to house officer. Injury to the musculospiral nerve and breaking of bone screws resulted so that fragments were not held in close apposition. Reoperated on May 20, 1930. Musculospiral nerve freed from adhesions and the usual technic of closure used, consisting of bone screws and silver wire. Firm union with splendid function of the arm obtained. This case emphasizes the importance of firm fixation between fragments. Even the slight separation that occurred from breaking of the bone screws resulted in an unsuccessful operation.

Case 7.—Mr. J. L., aged 45. Examination September 13, 1931. Patient sustained a fracture of the upper third of the right humerus. Was treated with an airplane splint for eight weeks. Presented the typical picture of a fracture of the upper third of the humerus with very marked bone atrophy. Operation, October 13, 1931. On exploration and freeing of fragments from fibrous tissue, bone was found to be so atrophied that it could be easily crushed with very light forceps and we were unable to get satisfactory approximation. House officers attempted a repair by use of silver wire and metal screws. Patient placed in plaster dressing for several weeks. Following this wore a splint to protect the shoulder and arm as he was awaiting the time when there would be sufficient remineralization of the bones to permit second operation. Second operation 21 months after original fracture, at which time there was considerable shortening of the humerus. Good apposition obtained and beef bone screws and silver wire used for

(CASE 9)

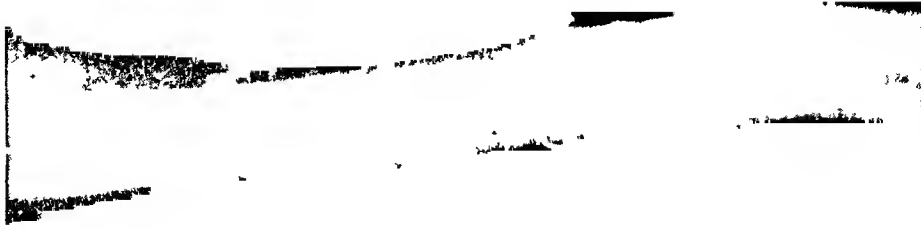


FIG 28—Mrs H C W, six months after injury.



FIG. 29.—Mrs. H. C. W., immediately after operation.

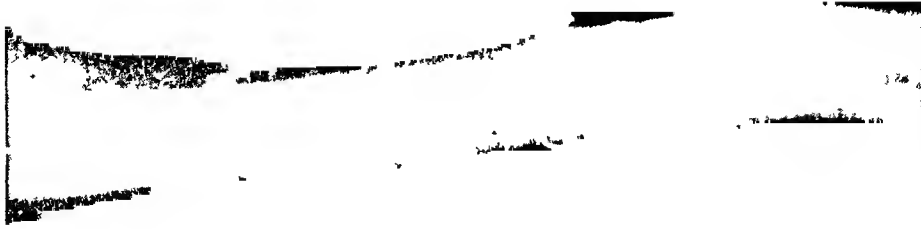


FIG 30—Mrs. H. C W, ten months after operation.

(CASE 10)



FIG. 31.—T. E. W., February 16, 1935. Aged 29. Un-
united fracture of humerus. Three years' duration. Several bone
grafts resulted in failure.

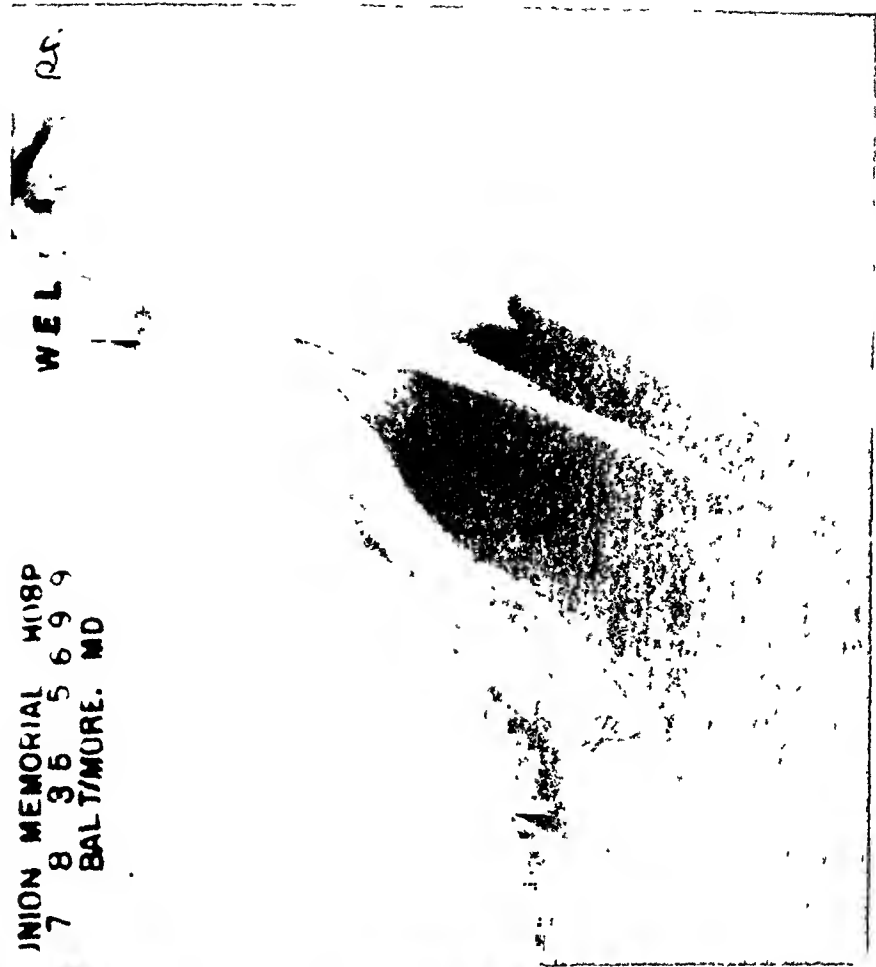


FIG. 32.—T. E. W., July 8, 1935. Five months after unsuccessful operation.
Partial absorption of lower fragment. Result—failure.

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immobilization together with plaster dressing. Patient made an uneventful recovery. Now has very satisfactory function of the arm with shortening.

Case 8.—Mr. E. H., aged 17. Examination November 18, 1930. Six months prior had sustained a very bad crushing injury to right arm with a tremendous loss of soft tissues in the middle third of the humerus; also a destruction of the musculospiral nerve and its associated paralysis. Treated immediately with Thomas splint and traction for three weeks followed by a traction splint with arm at right angles for a period of six weeks. This was apparently the only method of treatment that could be used at the time of injury as the soft tissue damage was so great that consideration had to be given it. Operation, November 20, 1930, usual type of procedure, converting fracture into oblique type and fixation with beef bone screws and silver wire. During the application of the plaster dressing the beef bone screws were broken which permitted very slight separation of the fragments. Patient did not get union. Second operation, March 24, 1931, placing beef bone screws and getting good apposition. Patient went on to an uneventful recovery. November 2, 1931, operation for transplantation of muscles of forearm. Patient now has a very satisfactory and useful arm.

Case 9.—Mrs. H. C. W., aged 41. Admitted to Church Home and Infirmary, January 25, 1931, six months after fracture of middle third of left humerus. Unable to get satisfactory description of early treatment used. Presented typical picture of an ununited fracture of the left humerus. Operation, January 25, 1931, usual type of conversion of fracture into an oblique one and fixed with beef bone screws and silver wire. Patient made an uneventful recovery, having firm union at the end of four months.

Case 10.—Mr. T. E. W., aged 29. In June, 1931, patient sustained a compound fracture of the right humerus. Open reduction with subsequent osteomyelitis and non-union. Four months later bone graft for fixation which resulted in non-union and infection. No evidence of infection since August, 1933. Wearing a brace since that date to protect arm. Operated on in February, 1935, approximately four years after original injury. An attempt was made to get good bone coaptation and fixation but at the time of operation it was very questionable whether this procedure would be successful as there was so little osseous material available. The result of the operation was a failure, as demonstrated by roentgenogram.

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THE DIAGNOSIS AND TREATMENT OF OSTEOMYELITIS

W. BARNETT OWEN, M.D.

LOUISVILLE, KY.

TODAY, it is quite generally accepted that osteomyelitis is a local manifestation of a general infection. It is blood borne. The portal of entry may be through either external or internal body surfaces; that is, the skin, the gastrointestinal, genito-urinary or respiratory tracts. Slight trauma is supposedly present at the site of entry. Boils, carbuncles and infections of the nasopharynx are often forerunners of acute osteomyelitis.

Speed³ and Clopton⁴ believe that the type of organism that gains admission into these sites has a specificity for bone, and this accounts for the establishment of an osteomyelitic focus. During the course of the general infection, a focus is established in the bone at a point of lowered resistance, this point having usually suffered previous trauma.

The trauma may be of internal or external nature. Wilensky¹ classifies these traumata into three groups, namely: (1) active, (2) passive, and (3) chemical. The active variety is due to an external injury. Passive trauma is the result of local temporary circulatory disturbances in a portion of the body, which is consequently deprived of its natural defensive powers, and, therefore, becomes a vulnerable point for blood stream infection to find lodgment. The cellular changes that ensue following obstruction to the nutrient blood supply lead to chemical trauma.

Under ordinary circumstances, if the individual is in excellent health, the natural defensive forces of the body will not permit localization of the disease at the point of injury. If, however, the person is suffering from any of those conditions (boils, carbuncles, *etc.*) which predispose to bacteremia, there may be localization of the disease at the injured point and an isolated focus will be established. The slowing of the blood stream and the tendency to thrombus formation in bacteremia will also aid in the production of the local lesion in the traumatized area.

The site of the thrombotic plug (whether sterile or infected) in the vessel is known as the fixation point. This interferes with the blood supply to a certain portion of the bone. Wilensky closely identifies these fixation points with bacteremic conditions which ultimately establish a definite infection in the previously sterile thrombus. He believes that even in health there are temporary, transient periods of bacteremia. These are classified into three groups. Each begins as a bacteremia:

(1) In the less severe and most favorable type, the bacteremia disappears after the establishment of the local lesion (fixation). The local bone lesion, therefore, is the matter of prime importance, and treatment should be directed toward the removal of this focus.

(2) The second type also starts as a bacteremia and establishes a bone focus, but unlike group one the bacteremia does not disappear. In this group the bacteremia is maintained or "fed" by infected thrombi and small embolic clumps of organisms that are liberated from time to time by the bone focus. Here, again, the therapeutic attack should be directed toward the local bone lesion, since this maintains both the local and general infection. A successful outcome in the treatment of the local lesion should produce a complete cure. If treatment is too long delayed, small thrombi may become separated from the parent focus and form secondary foci in distant portions of the body. These in turn may take part in the establishment of further subsidiary lesions.

(3) In the third class the bacteremia plays its all important part. The organisms are present and rapidly multiplying in the blood stream. The general blood infection and toxemia mask all evidence of local lesions. It is only by careful, systematic search that local lesions can be found. They are usually multiple and involve several organs. The treatment of the local lesion in this group is not to be considered. Efforts should be made to combat the toxemia and general blood infection.

The behavior of the "fixation point" is variable, as has already been mentioned. The thrombus of the local lesion may remain fixed in size and position. It may extend along the course of the vein in the direction of the blood stream, or there may be retrograde extension in a direction opposite to that of the blood current. Small segments of infected material may separate from the main thrombus and produce new scattered foci in the same bone or in other bones or organs. There are intermittent periods of bacteremia, associated with sudden development of fever, general malaise, leukocytosis, and possibly chills. Postoperative dressings and the necessary chiseling and other operative manipulations tend to scatter these foci by dislodging infected thrombi. The teachings of Cohn⁵ against chiseling and rough operative handling are, therefore, of great practical importance.

If we consider osteomyelitis from the standpoint of a mechanical plugging of isolated intra-osseous vessels with resulting local bone death, we will be able to explain the various clinical types of this disease with all its attending complications. If the main nutrient vessel is the site of thrombus formation, the entire shaft will be destroyed before the disease subsides. Plugging of the upper primary division will settle the fate of the upper half of the shaft. A block in the second division of the vascular network will lead to necrosis of a portion of the cortex in an isolated area, but not of the entire shaft circumference. Brodie's abscesses result from disturbed circulation of a terminal vessel that supplies the cortex. Thrombi may lodge in several distant small vessels of the same bone, and thus give a patchy, mottled, scattered necrosis. Various combinations of these clear cut clinical types may occur, depending upon the following factors, as noted by Wilensky:

- (1) The number, size and location of the plugged vessels.
- (2) The faculty and facility of the vascular anastomosis and collateral circulation.

- (3) The character and virulence of the infecting organisms.
- (4) The resistance of the subject.

According to this theory of the embolic nature of osteomyelitis, the minimal amount of bone necrosis is predestined after the thrombus has once plugged a vessel, irrespective of the time and kind of operative intervention. Clinically, however, we know that cases of acute osteomyelitis which are drained immediately do better than those in which treatment is delayed. Therefore, early surgery does prevent further bone necrosis. While immediate treatment cannot lessen the minimal amount of bone necrosis, we believe it is responsible for keeping the maximum bony destruction to the lowest possible level. This is consistent with clinical facts.

The intramedullary phlegmon, which originates through plugging of a vessel, will extend by contact and contiguity of tissue. The pus will fill the entire medullary cavity and finally emerge through a small (pinhole) opening in the cortex to form a subperiosteal abscess. Extension of the pus separates the periosteum from the bone and interferes with the periosteal blood supply. Further extension of the process may result in invasion of the epiphysis and joint, or in periosteal rupture with the formation of a soft tissue abscess.

If we now correlate Wilensky's ideas as to the cause and amount of bone necrosis with those of Speed and Clopton, which emphasize the damage done by extension of the infection, we arrive at certain definite conclusions with respect to the treatment of osteomyelitis, namely:

- (1) Remove the infected fixation point or focus of the trouble so as to prevent its spread into neighboring vessels.
- (2) Institute early adequate drainage to prevent pus from extending by contact and contiguity of tissue.

ACUTE OSTEOMYELITIS.—Since failure of recognition, or faulty treatment, of acute osteomyelitis is so frequently responsible for the chronic bone infections one encounters, it may be well to consider briefly the acute manifestations of the disease. Mention has already been made of the relationship of acute bone infections to suppurative lesions in other parts of the body, and the general blood infection that precedes the establishment of a focus in the bone.

Simmons⁶ and Clopton have reminded us of the frequency with which these cases are misdiagnosed as "sprains," "rheumatism," "growing pains," and "typhoid fever." The consequent delay in proper treatment permits the disease to progress and destroy areas of bone.

Simmons emphasizes the importance of trauma at the onset, and this has also been mentioned by Wilensky. Speed noted a history of trauma in 16 per cent of cases, while Cohn believes injury is probably present in 50 per cent of patients seen with acute osteomyelitis.

Both Clopton and Speed note the frequency of the disease during the actively growing period. Speed's series showed 80 per cent of the patients to be less than 15 years of age. The disease attacks the most actively developing and vascular portions of the bone, which accounts for its frequency at the upper end of the tibia and lower end of the femur. Speed shows that of 166

bones involved, 40 per cent of the lesions were in the tibia, 35 per cent in the femur, 7 per cent in the humerus, 7 per cent in the radius and ulna, and 2 per cent in the fibula, or a total of 91 per cent for these six bones. Of Simmons's 97 cases, the humerus was attacked in 15, the femur in 22, the fibula in 34.

Wilensky considers the region of the epiphysis a frequent site of the disease in children. Any child with pain in a limb and evidence of toxemia should always be suspected of having osteomyelitis. If the patient has had boils, or carbuncles, a recent attack of tonsillitis, or a slight injury, and develops a deep, boring pain over the shaft of a bone with local tenderness, fever, chills, leukocytosis and signs of toxemia, the diagnosis of osteomyelitis is almost certain. The pain precedes the point tenderness (Clopton) and this, according to Cohn, is due to tension caused by the intramedullary phlegmon. The leukocyte count may be between 20,000 and 30,000. There is inability to use the limb, but motion of the joint is painless, which excludes acute arthritis as a possible diagnosis. Light tapping over the bone will cause the pain to be referred downward along the shaft. This is designated as "point pain."

At this stage of the disease, when the diagnosis should readily be made clinically, roentgenologic examination reveals no changes. The appearance of changes in the roentgenogram is variable with the patient, but usually there are no conclusive roentgenologic signs of osteomyelitis until about the tenth day. Thickening of the periosteum is first noted on the film, and this is seen to extend far beyond the intramedullary involvement. Later, there are signs of intramedullary mottling and possibly changes within the cortex.

Treatment should be instituted as soon as the clinical diagnosis is made. To await roentgenologic confirmation of the diagnosis would be exceedingly hazardous to the patient.

Most authors agree that the disease is primary in the medullary cavity, and for that reason one should provide for adequate drainage of this closed space by removing a segment of the cortex. One should not be satisfied after incising the periosteum and allowing the escape of the subperiosteal collection of pus, but should trephine the shaft, beginning near the epiphysis, and if pus is found in the medullary cavity, as will usually be the case, sufficient bone should be removed to afford proper drainage. Clopton says it is a problem of doing enough, and still not too much; and Cohn believes the treatment should be a "conservative-radical operation."

Cohn employs an electric trephine and burr, and strongly advises against chiseling, because of the real danger of a cerebral fat embolus. The medullary cavity and endosteal cells should not be curetted, because these structures are required in the process of repair and the formation of new bone.

Lewis⁷ drains the periosteum first, and if the toxemia persists he then opens the shaft. Rast⁸ (quoted by Lewis) reports a mortality of 7 per cent after simple incision and drainage of the periosteum, and 14 per cent when the medullary cavity is opened. This seems unusually high.

Hedri's⁹ sign, or the presence of lipuria (fat droplets in the urine) in cases in which there is extensive infection of the medullary cavity, should be helpful in determining whether a simple periosteal incision will suffice, or whether the subperiosteal collection of pus is only a minor feature and marks the extension of infection from the medulla. Clopton believes that in one-half the cases more than one bone is involved (not simultaneously).

The prognosis depends on early recognition and prompt, energetic treatment. It was because of this fact that Murphy¹⁰ taught that acute osteomyelitis and gangrenous appendicitis warranted an immediate emergency operation. Simmons advises trephine of the shaft if in doubt, since so little harm can follow such a procedure if the diagnosis is incorrect, whereas much time and suffering for the patient will be saved if the diagnosis is confirmed at operation. The same author gives favorable prognosis in acute osteomyelitis if promptly and properly treated. In cases of osteomyelitis associated with a massive general blood stream infection, as noted by Wilensky, the general toxemia may mask the local bone lesions. In such instances, systematic examination of the bones should be made. The removal of a single local focus in so severe an infection will probably have very little effect on the ultimate outcome. Patients of this type require blood transfusion, intravenous glucose solution, and fluids in all forms, by infusions, *etc.* An exsanguination transfusion, though a heroic measure, seems warranted in so desperate a condition.

It was noted by Clopton that nine out of ten cases of osteomyelitis owed their origin to *Staphylococcus aureus* infection, and Speed found this true in 11 out of 12 cases. The experience of others has shown the *Staphylococcus aureus* to be the most frequent offender.

In the treatment of any disease, a satisfactory outcome is dependent upon a thorough understanding and appreciation of the mechanism involved in the production of that disease. This is especially applicable to osteomyelitis.

The work of Wilensky has done much to correlate the pathologic and roentgenologic changes with the clinical course of the disease. He has made a special study of the circulation of the diaphysis and epiphysis, and the bony necrosis resulting from thrombosis occurring at various points along this intra-osseous vascular network. After injecting the blood vessels of the long bones with opaque material, similar to that used by Lexer, Kuliga and Turk,² he could demonstrate a separate blood supply for the diaphysis and the epiphysis, with an avascular area between the two. This avascular area is especially marked before ossification of the epiphyseal cartilage has occurred.

The epiphysis receives its blood supply from numerous separate vessels, even though there is ordinarily one main channel. The diaphysis, however, is usually dependent upon a single nutrient artery for its supply. This main vessel enters the bone slightly to one side of the center of the shaft and separates into primary divisions to supply the upper and lower portions respectively. The primary branches later separate into secondary divisions, and finally end as small terminal vessels supplying the cortex. There is free

anastomosis within the intra-osseous substance, and the periosteal vessels communicate therewith by means of Sharpey's fibers passing through the haversian canal.

Treatment.—For many years we have adhered very closely to the methods employed by Orr in the treatment of both acute and chronic osteomyelitis. His principles are as follows:

(1) Adequate drainage.

(2) Removal of all sequestra, thoroughly saucerizing the affected shaft, using preferably a motor drill and circular saw, avoiding undue trauma and manipulation, leaving the bony cavity with a smooth surface, accomplished by the use of a file.

There is no chemical solution used in the wound. Vaseline gauze pack is firmly but not tightly placed in the entire bony cavity, packing the soft tissue entirely open and covering the incision with vaseline gauze. No sutures are employed. The limb is then placed in the most favorable position and maintained in fixation by plaster of paris dressing; always including the joint on either side of the affected bone. A window is then cut in the plaster case that will permit of frequent removal of the superficial dressings, not disturbing the wound for a period of at least three weeks, following the operation. This is a slight variation of Orr's after treatment. At the end of three weeks, in the majority of instances, we remove the case entirely and depend upon hydrotherapy treatment. The patient is put into a tub of water for about four hours a day—two hours in the morning, which is again repeated in the afternoon. The vaseline gauze packing, primarily inserted, is removed at the end of three weeks, at which time healthy granulations will be noted over the entire bony cavity. There is always a small strip of vaseline gauze used to prevent the wound from closing before it has had an opportunity to granulate from the bottom. Our percentage of recurrences has been much less since we have been employing this method of management.

We have employed a number of different methods during the past 25 years but will omit any comment on the other types, because the one we now employ has produced the most satisfactory results in the shortest space of time, with the smallest percentage of recurrences, and with the lowest mortality.

CONCLUSIONS

(1) We cannot emphasize too strongly the importance of early diagnosis and employment of adequate drainage in acute osteomyelitis.

(2) The principles to be borne in mind are thorough and careful removal of diseased bone; the employment of the type of drainage that will permit the wound to granulate from the bottom; absolute rest of the affected parts.

(3) Serious consideration of the general constitutional condition of the patient with employment of such reconstructives as are indicated in each particular case.

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DISCUSSION.—DR. WILLIAM B. COLEY (New York).—I should like to say a word about the extreme difficulty of making a differential diagnosis of chronic osteomyelitis and bone sarcoma. I recall four cases in which the clinical diagnosis of osteomyelitis was confirmed by histologic examination, and yet the condition proved to be sarcoma. In some there was a history of antecedent local trauma, and in others, there was not. As a matter of fact, a history of antecedent local injury does not give much help in making a diagnosis in these cases, since such a history has been noted in 35 per cent of our cases of osteomyelitis, and in about 50 per cent of our cases of bone sarcoma.

CASE REPORTS

Case 1.—A man, aged 20, developed a swelling of the upper and middle portion of the femur shortly after a local injury. It gradually increased in size and was associated with pain. An exploratory operation was performed at the Jewish Hospital August 7, 1923, and a microscopic diagnosis of osteomyelitis was made. About two years later the patient was admitted to the Hospital for Ruptured and Crippled, where the same diagnosis was made. I saw him for the first time about two months later. In the interval, marked changes had occurred: there had been an increase in the activity of the disease, and both the clinical and roentgenologic evidence strongly suggested a sarcoma. Another exploratory operation was performed, and on microscopic examination the tumor proved to be an osteogenic sarcoma, highly cellular, without new bone formation. In view of the fact that the patient would not give his consent to an amputation, conservative treatment was employed. Under Coley's toxins and irradiation, there was evidence of marked improvement. However, at the end of a year, metastases developed, causing death in a few months.

Case 2.—At about the same time, another case of tumor of the femur was observed in a young man, on which a biopsy had been made at the Broad Street Hospital, and a diagnosis of osteomyelitis had been made from the clinical, roentgenologic and histologic evidence. The condition became worse and he was admitted to the Hospital for Ruptured and Crippled two months later. A diagnosis was made of sarcoma from the clinical and roentgenologic evidence, which was confirmed by microscopic examination of another biopsy specimen. In spite of an immediate amputation, followed by prophylactic treatment with Coley's toxins, pulmonary metastases developed causing death within a year.

Case 3.—A young boy, aged 14, entered the Hospital for Ruptured and Crippled in December, 1922, with a tumor involving the upper third of the femur, which, in clinical and roentgenologic examination, was diagnosed osteomyelitis. An extensive biopsy was performed and a microscopic diagnosis of chronic osteitis or osteomyelitis was made. At the end of one month, the wound having healed, the patient was discharged from the hospital. He returned in February with an enormous tumor of the upper half of the femur which was undoubtedly a sarcoma, quite inoperable. On reviewing the microscopic sections, the condition was pronounced an endothelial myeloma or Ewing's sarcoma. Under irradiation and Coley's toxins, the tumor nearly disappeared in one month, but it later showed evidence of increased activity, produced general metastases, and caused death in June.

Case 4.—A man, aged 48, was admitted to the Hospital for Ruptured and Crippled in August, 1927, with a history of steadily increasing pain in the lower end of the femur; no marked swelling. Roentgenograms showed a central tumor with the characteristics of a giant cell tumor that had not broken through the bony shell. A diagnosis of osteomyelitis was made by Dr. Armitage Whitman. He performed a curettage, removing a small tumor the size of an English walnut from the central portion of the femur. A microscopic diagnosis of osteogenic sarcoma was made by Doctor Jeffries. The patient was then referred to me. I advised immediate amputation, to which the patient would not consent. In the meantime, I showed the sections to one of the most experienced pathologists in bone sarcoma, who made a diagnosis of chronic osteitis with no evidence of neoplasm. In view of this report, and although the patient had changed his mind and said he would permit an amputation, I decided to try to save the leg by conservative treatment. He was admitted to the Memorial Hospital and given all the radium treatment his skin would stand, combined with Coley's toxins systemically. In spite of treatment, the pain became more intense, and amputation was performed. The pathologic report was osteomyelitis. I still adhered to my original diagnosis, of malignant osteogenic sarcoma, on the ground that I had never observed a tumor associated with such severe pain that was not malignant. In June, the patient complained of severe pain in the mid-scapular region. The roentgenogram was negative. Two weeks later, a metastatic bone tumor was discovered in the ribs and spine. This progressed very rapidly, causing death in May of the following year.

DR. W. BARNETT OWEN (closing).—There are many ramifications of osteomyelitis, many mistakes are made and many disasters occur. In one instance a man had been operated upon 20 years ago for osteomyelitis of the tibia. He came to me because of frequent hemorrhage into the skin and soft tissues. We took a specimen for examination and it proved to be an epithelioma. We amputated his leg and he has had no recurrence for five years.

MEMOIRS

JOHN ROACH WATHEN

1872-1935

JOHN ROACH WATHEN was born in Louisville, Ky., in 1872, and after a long and successful career in his natal city died there in 1935. He was the son of William Hudson and Kate Roach Wathen, a worthy offspring of a distinguished sire, his father having enjoyed throughout a long and active



JOHN ROACH WATHEN, M.D.

life an enviable position as teacher and surgeon. Doctor Wathen's education was begun in Louisville, there being graduated from the Male High School in 1891. He then attended Yale University, receiving the B.A. degree in 1895, after which he returned to Louisville and entered the Medical School of the University of Louisville from which he obtained the degree of M.D. in 1898. He was associated in practice with his father until the

death of the latter in 1913, after which he carried on independently until the end. He was a tireless and indefatigable worker and deeply interested in the march of surgical progress during the fruitful decades which were allotted to him. He participated freely in medical society activities and was a frequent contributor to their programs upon a wide variety of subjects, being especially interested in the surgery of the prostate and thyroid glands. He was particularly proficient in the surgery of the latter and attained a distinctive position in this field. He was the author of *Normal Histology, A Manual for Students and Practitioners* (The Medical Epitome Series), 114 illustrations, 223 pages, published by Lea Brothers & Co., in 1903, which for some years was accorded rather wide laboratory usage. His society memberships included the Louisville Clinical and Jefferson County Societies, the Kentucky State and American Medical Associations; The American College of Surgeons, of which he was a founder; The American Urological Society and the Southern Surgical Association. He was admitted to membership in the latter in 1905 and placed on the roll of Senior Fellows in 1932. He held the position of Staff Surgeon to the St. Anthony and the Louisville City Hospitals and until his retirement from active teaching in March, 1932, was Clinical Professor of Surgery in the Medical School of the University of Louisville. Throughout a long and active career he maintained close contact with things medical and surgical, was an avid reader of contemporaneous professional literature and although in later years handicapped by hypertensive cardiovascular disease continued in active practice until the end, which came suddenly on May 25, 1935.

He is survived by his wife, Adah L. Poynter Piers Wathen, and two sisters, Mrs. Guthrie Wilson, of Coronado, Calif., and Mrs. John Rodgers, of Seattle, Wash.

IRVIN ABELL

JOHN SMYTH

1869-1935

DR. JOHN SMYTH was born November 16, 1869, in Tensas Parish, La. He descended from a long line of distinguished Scotch-Irish ancestry. His uncle, Dr. Andrew Woods Smyth, attained prominence as House Surgeon



JOHN SMYTH, M.D.

of Charity Hospital, New Orleans, and is recalled particularly because of having performed the first successful ligation of the innominate artery in 1864. Another uncle, Dr. William Woods Smyth, was a distinguished oculist and personal physician to King Edward VII of England.

Doctor Smyth's early education was directed toward becoming a civil engineer, graduating from that department of Tulane University, in 1886,

which profession he then followed for ten years. At the age of 27, in 1896, he entered the Medical School of Tulane University. His previous education, practice and experience in engineering served as a most admirable preparation for the scientific study of medicine and surgery. He received his degree in Medicine in 1900. For the succeeding nine years he was affiliated with Doctor Matas, during which time he applied his knowledge of physics and mechanics in the development and utilization of the roentgen ray for diagnostic and therapeutic purposes and with which he obtained results that were amazing when his rudimentary equipment is considered. His many contributions during this period demonstrated his great technical skill and discriminating knowledge of the potentialities and limitations of this modality, far in advance of the experience of his time.

In 1902, he was appointed Instructor in Chief of the Laboratory of Minor Surgery which was, at that time, established by Doctor Matas, and rose rapidly by successive steps to become Assistant Professor of Clinical Surgery. In 1917, he entered the World War serving on the Surgical Staff of Base Hospital No. 24, rising to the grade of Major and being discharged with the rank of Lieutenant Colonel. He was honored by receiving the United States Military Cross. After the war, he returned to Tulane University and was appointed Professor of Clinical Surgery.

While interested particularly in roentgenographic technic and roentgen therapy, Doctor Smyth demonstrated his mechanical genius and inventiveness also in experimental research on physiologic and pathologic effects of positive and negative atmospheric pressure on the lung and the respiratory function, in states of pulmonary collapse induced by acute surgical pneumothorax, which observations culminated in the perfection of an apparatus which furnished basic data for accurate and rational application of intralaryngeal insufflation in intrathoracic operations.

In addition to his earlier writings on roentgen technic and therapy and the mechanics of artificial respiration in thoracic surgery, he wrote extensively on bone transplantation for closure of cranial vault defects, fractures, arthroplasty, hernia, gastric and duodenal ulcer, gastro-enterostomy, oral anesthesia and analgesia, interpretation of abdominal pain and endo-aneurysmorrhaphy.

During the last 33 years of his life, the bulk of his practice was centered at the Hotel Dieu. His skill is remembered gratefully by countless patients and the memory of his charity and devotion to them will probably be his most enduring monument.

Though not gregarious in his tendencies and always retiring, unpretentious and reserved, he was a strong believer in organized medicine and became early a member of the local state and national organizations. He was a Fellow of the Southern Surgical Association from 1920 to 1935; American College of Surgeons; Association of Military Surgeons; Association of Traumatic Surgery and Endocrinology.

In 1911, he married Miss Jeanne Sully and is survived by his widow and

two sisters. His fatal illness resulted from an hypernephroma which caused a complete portal obstruction.

After a most pleasing intimacy lasting 37 years, the writer can express his sentiments only by repeating those which he offered in personal tribute at the time of Doctor Smyth's death:

"Our early personal and professional relations ripened into a warm friendship, based on mutual regard, trust and affection which never faltered or suffered an instant of doubt or hesitation. As a student, he drew me by his earnestness, studiousness, sincerity and high sense of duty. Later, as an assistant and colleague, I found him true as steel, the incarnation of honesty, the soul of honor and unswerving loyalty. Very discriminate in his friendships, his affection and fidelity to those to whom he was attached was indeed a prized privilege and a great compliment.

"As a surgeon he was conscientious and cautious to an extreme degree, fastidiously meticulous in every detail for the patient's safety, anxious to do no harm if he could do no good. All conscientious surgeons share in the same anxieties, but his sense of responsibility so worried him before and after any serious operation, that it imposed great hardship upon his energy and his sensibilities by his sleepless vigilance. This made him extra cautious and deliberate, where others of far less knowledge did not hesitate. His solicitude and care for his patients, poor or rich, won their confidence, and rewarded him by their grateful affection and friendship. Many who shed tears at his funeral mourned his loss as a veritable calamity.

"In his professional relations with his colleagues, Doctor Smyth was always courteous and punctilious in observing the Golden Rule, treating others as he wished them to treat him.

"He met death like a true doctor. Conscious almost to the last, he bore his trials with a calm and stoic fortitude, an equanimity of spirit characteristic of his courage, and becoming a physician who had met Death and stayed his hand too often to be fearful of his presence when he came, not as a foe, but as a friend to ease him of the pangs of a disease which he knew was beyond all power of human help to conquer. He passed away painlessly and in peaceful slumber, attended by the loving hands of those dearest and closest to him."

RUDOLPH MATAS

ERNEST SYDNEY LEWIS

1840-1935

DR. ERNEST SYDNEY LEWIS, soldier, educator, surgeon of international reputation, scholar and gentleman, died in New Orleans, August 12, 1935, at the age of 95.



ERNEST SYDNEY LEWIS, M.D.

He was distinguished in so many ways, so modest in every way, so useful to his community and to the medical profession at large, that it is almost impossible to summarize his attainments or to express the affection and esteem in which he was held by the citizens of New Orleans and particularly by his professional confreres. For 73 years he was truly a leader in his profession, being practically continuously active since he became House Surgeon of Charity Hospital. He was the oldest graduate of Tulane Uni-

versity, one of its most distinguished alumni, and his splendid service as teacher and advisor in the School of Medicine for 45 years contributed materially to the prestige and traditions of the University.

Doctor Lewis was born in New Orleans, September 24, 1840. The responsibility of his medical education was assumed by an uncle, Dr. J. H. Lewis. In 1859 he entered the University of Louisiana (Tulane University) from which he received his degree as Doctor of Medicine in 1862. He served during the Civil War as House Surgeon at Charity Hospital and subsequently with General Bragg's army, in which he attained the position of Brigade Surgeon and later was commissioned Medical Director in Wheeler's Cavalry Corps. After the war, he returned to New Orleans and resumed work at Tulane University as assistant of Dr. Stanford E. Chaille in Anatomy and later in the Department of Physiology. Becoming Health Officer of the State Board of Health in 1867, he was very active in the fight waged at that time against Asiatic Cholera and Yellow Fever. He married Susan Daggett Phelph McCoy of Massachusetts in 1866, and had nine children.

In 1874, Doctor Lewis was appointed Professor of Materia Medica, Therapeutics and Clinical Medicine at Tulane University, being subsequently, in 1876, appointed Professor of Obstetrics, Gynecology and Diseases of Children, which chair he held for 36 years when he was appointed Professor Emeritus. He was continuously connected with this institution until his death. It was in the field of gynecology and obstetrics that he introduced fundamental changes through the application of principles of Lister and Pasteur, of which he was a leading exponent. His experience in Charity Hospital was enormous and he enjoyed as well a very large private practice which kept him so engaged that he had but very little time to attend medical meetings and regretted greatly his inability to visit other clinics.

He was one of the founders of the Orleans Parish Medical Society and of the International Association of Obstetrics and Gynecology, and President of the Southern Surgical and Gynecological Association in 1896. In recognition of his life of public service, skill and learning as a surgeon and devotion to the highest traditions of medical conduct, in 1916 the American College of Surgeons conferred upon him an Honorary Fellowship. Tulane University, in 1922, conferred upon him the degree of LL.D.

Doctor Lewis' record of service at Charity Hospital was parallel and equal to that rendered at Tulane University. It is interesting to note that he performed his last operation at the age of 87. He was a man of wide learning and culture. His naturally philosophic mind was further developed by the study of Grecian philosophy which undoubtedly influenced him greatly in meeting his many trials with stoical fortitude and afforded him an exceptional outlook on life. He had a most intimate knowledge of its history and could expound in detail the particular theory of each philosopher. He was a facile and charming conversationalist, in French as well as in English, and a brilliant public speaker. His fondness of poetry was exemplified by

his ability to recite verbatim quotations and even complete verses which he had not heard for years. Although possessing strong personal convictions, he was never dogmatic, probably because he knew the exceptions to every theory. He was a man of great humaneness and sympathized with the unfortunate, giving his service equally to the rich and poor. He was a friend of the young man, and many physicians, at present prominent, owe their success to the advice, assistance and opportunities which Doctor Lewis placed in their paths.

One can only regret that Doctor Lewis left so little in written form of the many phases in the advancement of his specialty and of the observations which he could have made in his achievements as teacher and surgeon. His few contributions, however, were of the highest merit, but his enormous amount of work gave him little time for writing. His memory will live, not only with those who knew him personally, but as a tradition of the South, which claims him as one of its most illustrious sons.

C. JEFF MILLER

ADDENDUM

Referring to article on "The Treatment of Compound Fractures with Special Reference to the Orr Treatment," by Damon B. Pfeiffer, M.D., and Calvin M. Smyth, M.D., appearing in the ANNALS OF SURGERY, Vol. 102, No. 6, Dec., 1935, p. 1059, line one, page 1060, "Sherman of Pittsburgh" should be corrected to read "Estes of Bethlehem, etc."

"Through an error, credit for the advocacy of immediate closure was given to Sherman of Pittsburgh, instead of to William L. Estes and William L. Estes, Jr., of Bethlehem, Pa., who have both practised it with excellent results for many years."

CALVIN M. SMYTH, JR.

EDITORIAL ADDRESS

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